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THE SIGNIFICANCE OF XANTHOCHROMIA OF THE CEREBROSPINAL FLUID

WITH REPORT OF A CASE IN A PREMATURE INFANT*

ISAAC A. ABT, M.D., AND I. HARRISON TUMPEER, M.D.

CHICAGO

This case is reported because of the occurrence of yellow spinal and ventricular fluid in an infant of eight months period of gestation who lived thirty-seven days and who also manifested marked internal hydrocephalus, pyelitis and bronchopneumonia. In the literature the term xanthochromia covers a variety of cerebrospinal fluids with different properties. Some insist that this name should be applied to yellow fluids which coagulate *en masse,* as Froin first described. Others reject the term xanthochromia when applied to fluids containing red blood cells. They propose the term erythrochromia for this condition. Our case was one of yellow cerebrospinal fluid containing red cells due to subpial hemorrhages. Because of the confusion and lack of agreement concerning our chief interest in this case, we will be obliged to interpret our conception of the condition called xanthochromia in order to present intelligently the findings.

The common properties of all xanthochromic fluids are yellow color and increased globulins. After these have been eliminated, the other considerations such as massive coagulation, pellicle formation, cell count and the presence of erythrocytes, are variable factors. The syndrome of xanthochromia most frequently mentioned is Froin's, or the complete syndrome which includes yellow color, massive coagulation and increased globulins. The cell count varies. Some include and others disregard the cells in their discussions because they have not analyzed their significance. It seems unnecessary to mention increased globulins where coagulation occurs, because coagulation without an increase in albumen is inconceivable. As a matter of fact, fluids with xanthochromia all have increased globulins, although the quantity may differ. Nonne has described what is now termed the

* Read before the American Pediatric Society, Highland Park, Ill., May 31, June 1 and 2, 1920.

incomplete syndrome, that is, yellow color with increased globulins, although massive coagulation does not occur. There seems to be considerable evidence, as we shall see later, that Nonne's is an earlier or less complete development of Froin's syndrome. In general, it has been pointed out that the French emphasize the coagulation feature, while the German school speaks of the increased globulins, not mentioning the presence or absence of coagulation.

The whole situation resolves itself into the question of what causes the yellow color. Ultimately, the yellow pigment is hematogenous in origin. Mix [1] states that the pigment has been identified as hemolytic biliary pigment by Donath, as bilirubin by Blanchetriére and Lejonne, and as urobilin by Fornaca. Raven suggests that the color, in the last analysis, is due to blood pigment from multiple small hemorrhages because in his 47 cases, the yellow color was caused by an old hemorrhage. His conclusions hold only so far as those cases are concerned. Other causes must be assigned where no demonstrable hemorrhage is present. However, his opinion is confirmed by the case of Blanchetriére and Lejonne, a vascular cord tumor with multiple hemorrhagic foci. There were only a few red cells in the fluid, and they suggest that there were small continuous hemorrhages from the tumor over a period of sixteen months. All these cases might be classed as erythrochromic so far as the presence of red cells is concerned. There are other views concerning the pigment which refer particularly to the other types of xanthochromic production. Gordon [2] remarks that the pigments accumulate in greater concentration where there is a limited area for absorption as in a culdesac or in the cutting off of the spinal subarachnoid space in hydrocephalus. Inasmuch as absorption from the spinal subarachnoid space is all by way of the blood stream, and this course is closed by compressions and inflammations, as in the complete syndrome of xanthochromia, the pigment will have to accumulate in the meningeal pouch so formed. Thus, Raven, on the one hand, explains the yellow color on the basis of hemorrhage entirely, and Gordon, on the other, takes into account only the compression syndrome. Both are xanthochromic fluids, although the former may be termed erythrochromic and the latter the true Froin syndrome with the absence of red cells.

Instead of considering the other properties of xanthochromic fluids separately, we shall find that they can all be explained in a discussion of the pathogenesis of yellow color itself. This will simplify the problem and permit a more lucid presentation of the subject itself. The most usual form of xanthochromia is that associated with com-

1. Mix: Surg. Clin. **4**:317, 1915.
2. Gordon: Canad. M. A. J. **9**:1005, 1919.

pression of the spinal cord. Since first described in 1903, a large number of cases have been reported in the literature. Derrien, Mestrezat [3] and Rogers claim they were the first to point out the importance of the formation of a meningeal pouch in the production of xanthochromia. Siccard and Descomps were among the first to call attention to this fact, although they were wrong in their idea that the syndrome always spelled meningitis and never tumor. Indeed, since their time, most of the cases reported are cases of tumor. Everyone who has written on the subject has agreed to the importance of the pouch formation, and only recently Ayer [4] published some experimental work on the production of xanthochromia by compression produced by injecting paraffin into the spinal canal.

The obstruction may be produced by tumor, meningeal adhesions and trauma. The tumors may be of the ball-valve type, as Mix points out, and this will explain the variability of fluid findings which occur in some cases. Mestrezat showed that a transudate occurs into the meningeal pouch. In a closed cavity of this sort the elements necessary for xanthochromia and massive coagulation could come in two ways, as Horrax [5] states, either by transudation or by capillary hemorrhage the origin of which is not so clear although a few cases are reported with cord tumors. Mestrezat concludes that the physical and chemical properties of the fluid, together with the clinical and necropsy findings, demonstrate that a closed cavity and stasis of the fluid is necessary to the production of the syndrome. Therefore, there must be a closed cavity in which there accumulate the elements from the blood by transudation or hemorrhage, and, second, an alteration in the vessel walls of the cavity, either infectious or toxic, permitting the process to occur. It is usually a transudate. There is diminished pressure in the culdesac because the spinal fluid above the compression is shut off. The veins are dilated at the compression so that it is easy for transudation to occur. There is a high albumin content, and thrombin and fibrinogen also pass out. Mix states that these are the most characteristic constituents. Coagulation may occur in the needle itself, but sometimes it takes as long as a few hours to occur. The clot separates out from the fluid as a blood clot behaves. He points out that the fibrin content runs close to the amounts found in the blood. Hanes [6] states that the high content of xanthochromic fluids in fibrin and proteids and the presence of a few cells support the view that real blood comes with the transudate,

3. Mestrezat: Thesis Paris, p. 425, 1912.
4. Ayer: Arch. Neurol. & Psychiat. **2**:158 (Aug.) 1919.
5. Horrax: Arch. Int. Med. **17**:632 (June) 1916.

which is perfectly analogous to pleural transudates due to venous compression.

What determines the presence or absence of cells and what is their significance? Although we discussed the compression from the standpoint of the tumor, it is readily seen that the same symptoms might be produced by an inflammatory mass or traumatic process. In these cases the cell count is increased. Indeed, some authors suggest that an increased cell count differentiates tumor from inflammatory processes. Sprunt and Walker,[7] however, show that in seventeen of fifty-one cases of tumor the cell count was increased, and in one of their cases, a cord tumor, there were 61 mononuclear cells.

The formation of a pellicle is to be expected where there is a meningitis with insufficient compression to cause massive coagulation. It may also occur in the early stage of a tumor. Cooper[8] describes a case of angiosarcoma of the cord which showed edema of the membrane below the point of construction from which yellow fluid was withdrawn. A cobweb-like coagulum formed when the fluid was allowed to stand. There were no cells, and the globulins were increased.

The total absence of coagulation may also be explained. In the compression type of case it is a matter of duration of the process and the completeness and extent of the compression. Ayer[9] states that the most important variation gives a fluid which superficially does not seem to have any relation to the complete syndrome. Where presumably the pressure on the cord has been insufficient to shut off the spinal fluid we find a fluid of normal appearance, colorless, under normal pressure, but containing an abundance of globulins. This fluid does not clot and may not contain cells. Such a fluid corresponds more closely to Nonne's incomplete syndrome. As a variation from this the yellow color may be present. Hanes attempts to prove that Nonne's is only an earlier stage of the same process that gives Froin's syndrome. However, it may as well be a question of extent of obstruction as duration. Hanes states that the complete syndrome may never be reached, but that the yellow color, increase in proteins and cells may be the only evidence of cord compression. What has been said regarding cell increase should be recalled here. Nammack[10] recently reported his observations on 5,801 spinal punctures. He quotes the ninety-two cases of tumors and other chronic surgical conditions of the cord by Elsberg and Rochefort[11] in which there

7. Sprunt and Walker: Johns Hopkins Hosp. Bull. **28**:80, 1917.
8. Cooper: J. A. M. A. **55**:2298 (Dec. 30) 1910.
9. Ayer: Med. Clin. **1**:1143 (Jan.) 1918.
10. Nammack: Am. J. M. Sc. **159**:540, 1920.
11. Elsberg and Rochefort: J. A. M. A. **68**:1802 (June 16) 1917.

were twelve fluids with xanthochromia, seven of which gave the complete syndrome. Of his own cases there were ninety-six, or 1.6 per cent., of yellow spinal fluids. In only six of his cases was the complete syndrome found. Yellow fluids occurred in two-thirds of his cases of tuberculous meningitis. He concludes that the smaller incidence of the complete syndrome in his cases was another indication that the earlier stages showed the Nonne syndrome, inasmuch as all his cases were acute or subacute affections. Incidentally, he remarks that a patient with meningeal symptoms and yellow fluid should be suspected of either tuberculosis or poliomyelitis. It may not be quite fair to include such cases of Nammack's with causes of cord compression because in the infections the factor of hemorrhage may play an important part. Blood cells are frequently found in tuberculous meningitis, and it is questionable whether hemorrhage alone gives the complete syndrome. The question of hemorrhage and its relation to xanthochromia we will consider separately. So far we have described the formation of yellow color, bringing in the explanations for massive coagulation, pellicle formation, cell increase and absence of coagulation.

The second type of process which gives xanthochromia without demonstrable compression phenomena is the process of continuous or multiple capillary hemorrhages. The compression phenomenon applied particularly to cord processes, although in Hane's case of a 9 months old child a tuberculous mass obliterated the pia arachnoid and completely encased the medulla at the level of the foramen magnum. The ventricular fluid was clear, but the spinal fluid presented the complete Froin's syndrome. The group we will now consider includes those cases of inflammation, neoplasms and trauma associated with red cells in the cerebrospinal fluid. The color of the fluids is due to dissolved hemoglobin or its derivatives, and they do not coagulate, as a rule. Because of the presence of erythrocytes some propose the name erythrochromia and place them in a separate category.

There are many cases in the literature illustrating the occurrence of yellow spinal fluid with conditions permitting the slow escape of blood. In 1904, Cestan and Ravaut published a case of pachymeningomyelitis of the conus. They considered two factors in the production of the complete syndrome, first, a meningeal inflammation with a sero-fibrinous exudate and, second, hemorrhage with solution of the red cells in the fluid with the appearance of the yellow color due to freeing of the hemoglobin. These two factors may coexist. In fact, Babinski regarded the syndrome of Froin as being due to a fibrinous hemorrhagic meningitis.

Another type of process recalls the case of Blanchetriére and Lejonne to which reference has already been made. This was a vascular cord tumor of the small round cell type which contained many hemorrhagic foci. There were only a few cells in the fluid, and they accounted for the yellow color on the hypothesis that small continuous hemorrhages had occurred over a period of sixteen months. In Raven's forty-seven cases the spinal fluid was stained by the hemoglobin derivatives from old hemorrhages. Rindfleisch, in 1904, had three cases of metastatic sarcoma of the brain and cord. In two the fluid was once dark golden brown while at another time the fluid was clear yellow. This expresses well the relation of erythrochromia to xanthochromia, if such a distinction is desired. The sediment contained erythrocytes and large cells with large nuclei, probably endothelial cells, and the proteins were increased. Section of the tumor showed hemorrhagic foci. Dufour, in 1905, described a case of diffuse sarcomatous meningitis with yellow fluid containing many lymphocytes, a few erythrocytes and several makrocytes. He states there was no bleeding in this case. Not all blood containing tumors give rise to red cells in the fluid. In 1906, Grund described a case of gliosarcoma of the spinal cord with yellow fluid but no cellular elements. The spectroscope showed no blood although the tumor was full of the blood and extended to the meninges. In 1907, Erb reported a case of carcinoma of the cervical vertebrae with yellow fluid but no blood. In 1911, Heilig reported cases of "erythrocyte pigmentation" of the spinal fluid.

Tuberculous meningitis often, if not usually, shows red cells in the spinal fluid when associated with xanthochromia. Reich [12] described a case of tuberculous meningitis in which the fluid was of a light bloody color but became a golden brown after centrifuging. In the sediment there were many erythrocytes, lymphocytes and an occasional polymorphonuclear leukocyte. Necropsy showed a hemorrhagic condition. He concludes that not only in tumors, but in cerebral hemorrhagic conditions yellow color of the spinal fluid may be found.

Xanthochromia with red cells is not limited to the conditions so far discussed, namely, Babinski's type of fibrinous hemorrhagic meningitis, cord tumors and meningitis of tuberculous and purulent origin. There is a wealth of evidence pointing to the responsibility of conditions within the cranial cavity in the production of the combination of yellow color and red cells. Tuffier reports cases of yellow fluid in skull fractures. Another case is cited of a patient who was ready

12. Reich: Mitt. a. d. Grenzgeb. d. Med. u. Chir. **25**:721, 1913.

to be operated on for brain tumor. The patient died, and at the necropsy a diffuse cerebral hemorrhage was found. In one of Rindfleisch's cases a brownish blood coagulum was seen in the fluid, and in this case there was a tumor mass adherent to the inner side of the lateral ventricle. In one of Erb's cases there was a hemorrhagic glioma on the right side of the brain. In this case, the first puncture yielded a clear fluid, but the second puncture showed red cells, polynuclear leukocytes and lymphocytes. These characteristics continued for some time. Further evidence of the cranial origin of the hemorrhage is furnished by Horrax's case. He reports the case of a boy aged 12 years, with a tumor of the pineal gland. The spinal fluid was straw colored, cloudy, and contained 1,011 old, disintegrating red cells and eighty-five white cells. There was no massive coagulation although the globulins were increased. From the ventricle of the same case 50 c.c. of yellow fluid with 561 old red cells and seventeen lymphocytes was obtained. Horrax states that many tumors grow into the ventricles accompanied by xanthochromia doubtless due to the escape of red cells from the surface of the tumor into the fluid. He reports having seen a number of such cases in his clinic. Sprunt and Walker hold that it is generally recognized that yellow color may occur in the spinal fluid after ventricular hemorrhage or hemorrhage into the subarachnoid space when the cells have disappeared almost entirely. They reviewed 100 cases from the literature and stated that there are some exceptions to the syndrome that cannot be explained on the basis of compression and obstruction. These usually vary from the complete syndrome in some particulars. Among the cases unexplainable on the theory of compression is a group of brain tumors in contact with the meninges in which the yellow color and other abnormalities could be explained by small hemorrhages into the subarachnoid space. In these cases, they state, there are crenated blood cells or positive tests for hemoglobin. To the number of cases we have already quoted in support of this view, they add a case of endothelioma of the dura in the left middle fossa and a case of arteriosclerosis, chronic diffuse nephritis and arterial hypertension with hemorrhage into the lateral ventricles.

Hanes attaches considerable importance to the condition he calls erythrochromia and sharply distinguishes this from xanthochromia. According to him, the name erythrochromia would have to be applied to any xanthochromic fluid containing red cells. This would necessitate a division of yellow fluids which would hardly be justified on etiologic or pathologic grounds as the cases we have described would indicate. We do not wish unduly to emphasize the hemorrhage factor

and we are inclined to agree with Sprunt and Walker that it is not necesary to presuppose minute hemorrhages to explain the color of the fluids in which there are no red cells and in which the most delicate tests for hemoglobin derivatives are negative and no bands appear in the spectrum. From the large amounts of fibrin and globulin it is evident that considerable transudation of blood plasma must have occurred. However, we think that certain conditions associated with hemorrhage have a definite place in the causation of xanthochromic fluids and cannot agree to a separation simply on the presence or absence of red cells. Essentially, the same process and origin of yellow fluid exists in both types. The process may better be understood if the whole question is simplified by classifying the conditions producing xanthochromia rather than to separate the syndrome on the grounds of more or less accidental variations in the fluid.

Hanes states that erythrochromic fluids are due to hemorrhage into the cerebrospinal fluid from ventricular apoplexy and traumatic rupture of meningeal vessels. We have already referred to cases of brain and cord tumors and cases of fibrinous and tuberculous meningitis giving red cells. He says that the color varies from bright red to a dark yellow and changes from day to day. Sprunt and Walker also state that in their experience the fluids containing hemoglobin are dark and have an amber tint, whereas those giving negative tests are of a lighter buff yellow. However, one of Froin's cases varied from cherry red to red, reddish yellow, light yellow to absolute limpidity. Nine punctures were made from the first to the twenty-first day of the illness. The red cells were present in diminishing numbers, and serum albumin and globulin were present in varying amounts. The spectroscopic evidence of hemoglobin disappeared some time before the fluid became colorless.

A case cited by Siccard and Descomps showed red cells in the serum and in the clot that formed almost immediately in a xanthochromic fluid. A second puncture six days later was yellow and clear, and a third, twenty-three days after the first, was entirely clear.

The mere presence of red cells does not take the fluid out of the category of xanthochromia where the fluid is really yellow. In fact, the red color, although not a genuine xanthochromia, may precede the yellow color in point of time and probably is due to continuous hemorrhage. Gordon agrees with this conception, for he states that in many cases of xanthochromia there are either free red cells or the evidence of chemical blood. In others there is no chemical evidence of hemoglobin, but he concludes, as we have already mentioned, that there is no evidence that the pigment is other than the normal pigment

of the blood plasma. In this connection let us again recall Rindfleisch's two cases of metastatic sarcoma of the brain and cord. The fluid in these cases was once dark golden brown while at another time it became clear yellow.

Hanes points out that another differentiating point is the constancy of the color in xanthochromia, but Siccard and Descomps have described the presence of xanthochromia and massive coagulation on some punctures and not on others. In Dimolet's [13] case, the first flow of yellow color actually changed to normal during the course of a single puncture. Sprunt and Walker cite a case in which a second puncture, performed three weeks after the first, yielded a clear yellow fluid with very faint globulin tests, and this at a time when the symptoms of compression were more marked.

The fluid may have the color of arterial blood and red cells or their shadows are found. In the minute type of hemorrhage, there will be no red color at all, and red cells have been found in fluids which were decidedly yellow and not contaminated with blood macroscopically.

Another objection to the red cells is based on the statement that leukocytosis of the fluid develops because of the meningeal irritation by the products of red cell destruction. However, in Horrax's case the ventricular fluid contained 561 red cells and seventeen lymphocytes. More white cells and more varieties should be expected. It is not denied that leukocytosis may occur, as in the case of Schwartz that Hanes quotes in his contention, but this is not a constant or characteristic part of the hemorrhage. It may be due to the infection producing the meningitis.

The fact that xanthochromia shows no red cells, and that there is neither chemical or microscopic evidence of hemoglobin derivatives is contradicted by Froin's first case, in which red cells were present, and Reichmann's report that he has often found the syndrome in cases of tumor of the brain and cord with yellow spinal fluid and multiple hemorrhages.

REPORT OF CASE

Our case belongs to the second type of yellow fluids, that is, the type not associated with compression but occurring with a process allowing blood to escape into the cerebrospinal fluid.

The infant was a premature baby, born during the eighth month of gestation. The mother had influenza and pneumonia. The child was brought to the hospital as a feeding case. The admission history stated that the child was

13. Dimolet: Rev. Neurol. **22**:648, 1914.

apparently well at birth and the labor was not difficult. The father was well. Two maternal aunts had tuberculosis, and one died of the disease. The mother of the baby had frequent attacks of bronchitis, but the family physician stated that the process was not tuberculous.

On entrance the temperature was 95 F., and the child weighed 3 pounds 14 ounces. The child was placed in an incubator, and the temperature rose to 98.6 F. the next day. Breast milk was given by gavage, and occasionally skimmed milk was given during the stay of thirty-four days. The weight steadily increased to 5 pounds 2 ounces. After a few days of subnormal to normal temperature, it tended to rise so that it frequently reached 102 F. during the first ten days of life. This was not deemed particularly remarkable in view of the prematurity with its unstable heat regulating mechanism.

On the twelfth day of life, the baby vomited two of its feedings. The vomitus was streaked dark brownish. The next day the baby vomited three times, and some separation of the cranial sutures was noted. This finding was not considered unusual because premature babies frequently show signs of hydrocephalus. The same evening twitchings of the entire body were observed. On the fourteenth day the temperature rose to 106 F. There were marked convulsions and spasticity. These symptoms continued until the end. There was an occasional râle in the right axillary region. The vomitus was dark brown, but the Weber test for blood was negative. The infant was catheterized, and only a few drops of urine was obtained. There were many leukocytes, some of which were in clumps, many granular casts, some of which were particularly large, and amorphous urates. No red cells were found. Subsequent urinalysis showed traces of albumin, reducing substance, acetone and granular casts, which diminished in number so that the last two specimens, on the twenty-first and thirty-second days, were free. Leukocytes persisted in the urine often clumped, and there were occasional red cells and epithelial cells. The cultures from the urine showed gram-negative bacilli and gram-positive cocci. There was no blood in the stool. A vaginal smear was negative; throat culture was negative; an eye smear taken from the discharge one day before death contained many leukocytes and a few cocci which were not morphologically gonococci.

The temperature tended to maintain itself between 99 and 102 F. for the rest of the time, although it was subnormal for the four days before death. On the twentieth day fine râles were heard in an area 4 cm. in diameter over the anterior surface of the left lung. They were heard at the end of deep inspiration after crying. Râles were also heard over the left upper lobe posteriorly. There were occasional râles over the right lung. The breath sounds were more distinct and sharper on the left side. Evidence of fine bronchitis persisted to the end.

On the twenty-fifth day two sharply demarcated, ulcerated areas appeared on the buttocks in symmetrical arrangement. That day the temperature was 104 F. The extremities were contracted and spastic. The diagnosis of meningeal hemorrhage was suggested. On the thirtieth day, in addition to the general spasticity, there was a sharp cephalic cry, and the anterior fontanel was bulging.

Spinal puncture yielded 4 c.c. of yellow fluid which appeared clear and in color resembled picric solution. A filmy pellicle separated out from the first tube in about five minutes. This tube contained the first 2 c.c. of fluid. There were 962 cells, most of which were polymorphonuclears. There were some red cells in the spinal fluid, but they were dissolved in acetic acid before the count was made. Therefore, some, at least, of these leukocytes came from the blood. Although massive coagulation did not occur, the expected large increase in globulins was proved by the Nonne, Ross Jones, Noguchi and Pandy tests, all of which gave heavy precipitates. Smears of the pellicle showed large num-

bers of polymorphonuclear leukocytes, considerable fibrin but no organisms by methylene blue, Gram or acid fast stains. The colloidal gold test showed reduction in the meningitic zone. The fluid was interpreted as indicating old blood in the cerebrospinal fluid. This would account for the yellow color, large quantities of globulin and cells. The predominance of white cells was accounted for on the theory that solution of red cells had occurred, leaving white cells and yellow color. The increase in polymorphonuclear cells would be explained on the increased polymorphonuclear content in the blood of the infant who also had a pyelitis and bronchopneumonia. This was probably the correct interpretation because the meningitis found on microscopic examination gave rise to round cell infiltration rather than polymorphonuclear cells.

On the thirty-first day, the spasticity of the extremities was still marked. On the thirty-second day the left lateral ventricle was punctured. Twenty c.c.

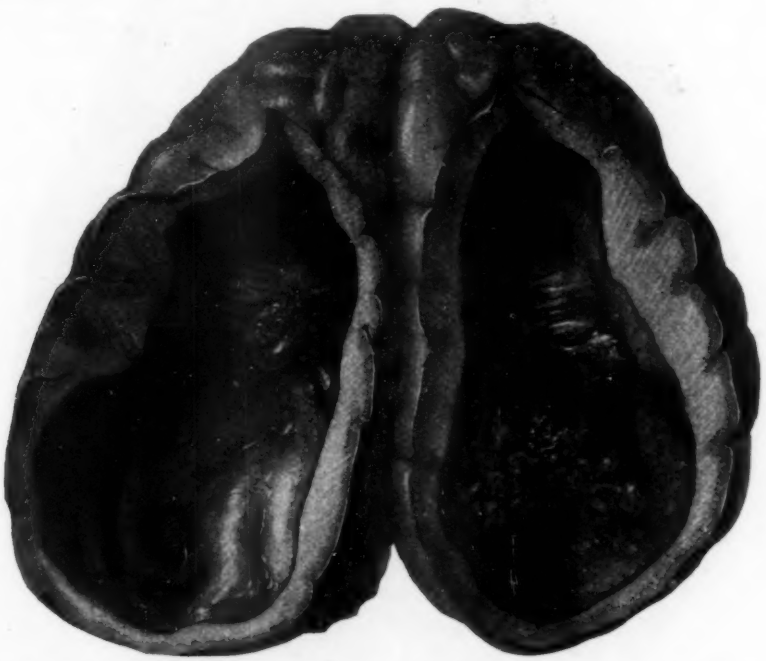

Fig. 1.—Lateral ventricles exposed, showing dilatation and exudate and enlarged choroid plexus. Exudate was pale yellow.

of deep yellow fluid was obtained under greatly increased pressure. Following the puncture, the child became quiet, vomited and the bulging of the fontanel diminished. There were ninety-one cells, of which 78 per cent. were polymorphonuclears, 16 per cent. lymphocytes and 6 per cent. endothelial cells. There were also red cells, and the benzidin test was positive. The globulins were increased, although not to the same degree that they were found in the spinal fluid. The ventricular fluid showed reducing substance. No bacteria were seen on smear, and in the cultures of both spinal and ventricular fluids there were no organisms. The Wassermann tests on both fluids were negative. The child died on the thirty-seventh day.

The necropsy was performed seven and one-half hours after death by Dr. Oscar Schultz. The fontanels were open and protuberant. When the dura was

incised, considerable yellow fluid escaped. The inferior surface of the brain was yellow and was covered in areas by a layer of soft, pale yellow exudate between which the pia appeared congested and thickened. The lateral ventricles were distended and contained a slightly cloudy yellow fluid. The fluid of the right lateral ventricle was darker than that of the left, but there was no brownish tinge. There were loosely adherent masses of opaque, yellowish white, soft material on the floor of the right ventricle. The right choroid was transformed into a soft red fleshy mass 2.5 cm. long and 0.6 cm. wide. The fourth ventricle was greatly distended. The dura of the cord was normal. The outer surfaces of the pia anteriorly had a yellowish tinge, and in the thoracic

Fig. 2.—Fourth ventricle, showing dilatation.

region the pia was thickened by a layer of grayish white material between pia and cord. Smears from the ventricular fluid and from the fibrinous material of the right ventricle contained no bacteria. In cultures from these sources a very small number of staphylococcus colonies developed.

Microscopic examination by George B. Hassin revealed a marked perivascular infiltration with lymphocytes and plasma cells, and marked vascular proliferation diffusely over the brain and cord. There were parenchymatous changes in the ganglion cells and proliferation of the glia. The markings between the gray and white substance were totally obliterated. There were areas of softening in the deeper layers of the white matter crowded with

fat granular bodies. In one area a clump of bacilli was seen. The pia was markedly infiltrated with lymphocytes and plasma cells. There were numerous hemorrhagic foci. Throughout the specimen there were many microphages packed with hemoglobin and red cells. Careful microscopic examination ruled against the diagnosis of tuberculosis, although the original impression of a tuberculous lesion might have been made from a gross examination of the surface. He concluded that this was a case of meningo-encephalitis of some infectious origin and that the xanthochromia was undoubtedly due to numerous subpial hemorrhages.

The rest of the necropsy findings may be summarized briefly: The body was that of a poorly nourished white female 45 cm. long. There was very little subcutaneous fat. The serous cavities were normal. The foramen ovale was open to the extent of 2 mm. in diameter, otherwise the heart was normal. Both lungs were congested posteriorly, and the posterior portion of the right lung was firmer than the rest of the tissue. On section this was red, had a fleshy appearance and contained little air. The abdominal organs were apparently normal. Microscopic examination showed that the heart was negative.

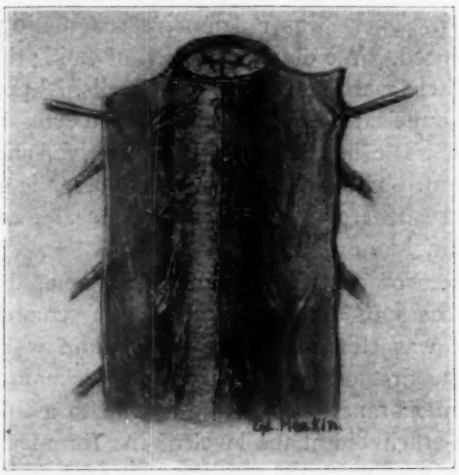

Fig. 3.—Cord showing fibrinous deposit. This was yellow colored.

In sections from the posterior portions of the lungs, the bronchi were filled with polymorphonuclear cells, and in some of them the epithelium was desquamated. The septal vessels were distended, and the alveoli were filled with polymorphonuclear leukocytes. In one lung the consolidation was diffuse and widespread. In the other the areas of consolidation occurred about the bronchi, and air containing alveoli were present between the consolidated areas. In the anterior portions of the lung the septa were thicker than normal, due apparently to incomplete expansion. The lymphoid tissue of the spleen was small in amount. The tissue was greatly congested. The liver cells were moderately swollen. The pelvis of the kidney showed the subepithelial stroma diffusely infiltrated by lymphocytes, plasma cells and eosinophils. In one kidney the pelvic epithelium was absent in an area of considerable size, and the adjacent tissue of the medulla was diffusely and richly infiltrated with polymorphonuclear leukocytes. The cortex showed no involvement. The ureter and bladder were negative. The vessels of the suprarenal medulla were distended. The anatomic diagnosis, therefore, includes bilateral acute hypostatic pneumonia, bilateral subacute pyelitis and unilateral acute pyelonephritis.

We are not prepared to state the nature of the infection causing the meningo-encephalitis and subpial hemorrhages in our case, although the finding of a clump of bacilli in a necrotic area of the brain stimulates speculation. The only other case in the literature that corresponds to the findings of xanthochromia and red cells in the spinal and ventricular fluids present in our case is that of Horrax. This case, to which we have referred, occurred in a 12 year old boy from whom 40 c.c. of yellow spinal fluid was withdrawn which did not coagulate. It contained 1,011 old disintegrating red cells and eighty-five white cells. Fehling's solution was reduced; the Noguchi test was positive; and there were no tubercle bacilli. In our case the red cells were not counted, but there were 962 cells, most of which were polymorphonuclear. The ventricular fluid from Horrax's case, of which over 50 c.c. was withdrawn, contained 561 old red cells and seventeen lymphocytes. There was no massive coagulation, and Fehling's solution was reduced. We obtained 20 c.c. of fluid; the red cells were not counted. There were ninety-one white cells, 78 per cent. of which were polymorphonuclears, 16 per cent. lymphocytes and 6 per cent. endothelial cells. The benzidin test was positive, and reducing substance was present. The difference in cell findings is explained by the fact that the case of Horrax was one of pineal gland tumor while ours was a meningitis.

Other instances of ventricular puncture are noted but no xanthochromia. The cases of Leitch [14] and Hanes demonstrated that the ventricular fluid was clear while the spinal fluid was yellow, due to obstruction in the first case by tuberculous thickening and adhesions of the cervical membranes, and in the second to a tuberculous tumor blocking the pia-arachnoid at the level of the foramen magnum. The youngest case hitherto recorded was the case of Leitch, of tuberculous meningitis in a nine months old boy.

Our case belongs to the class of xanthochromic fluids without massive coagulation and with red cells. It might be termed a case of the incomplete xanthochromic syndrome containing red cells. This case may never have reached the complete stage. It is interesting to recall that Cestan and Ravaut stated in 1904, on the basis of their case of pachymeningomyletis of the conus that two factors may produce the syndrome of xanthochromia, coagulation *en masse* and increased cells. Although ours is not one of the complete syndrome, the factors stated by these authors are pertinent. One of the conditions they mention is a meningeal inflammation causing a serofibrinous exudate; the other is hemorrhage with solution of the red cells giving the yellow color to the fluid by freeing the hemoglobin. In our case both factors existed. This coexistence would tend to confirm Babinski's contention

14. Leitch: Am. J. Dis. Child. **15**:348 (March) 1918.

of a fibrinous hemorrhagic meningitis. However, this is only one of the conditions and not the most frequent, giving rise to yellow cerebrospinal fluid. Our case refutes the statement that in hemorrhagic meningitis the fluid is always red.

Therefore, we report the case of an infant living thirty-seven days of eight months gestation with xanthochromia of the cerebrospinal fluid due to a meningo-encephalitis, with numerous subpial hemorrhages as the source of the coloration.

BODILY MECHANICS

ITS RELATION TO CYCLIC VOMITING AND OTHER OBSCURE INTESTINAL CONDITIONS

FRITZ B. TALBOT AND LLOYD T. BROWN
BOSTON

The consideration of the mechanics of the body, especially those which affect the abdominal and thoracic organs, has received a new stimulus during the last few years. Life in the army during the war did a great deal to stimulate this interest. It showed that a great many men were physicially unfit and made a large number of men physically more fit. The medical men who were in charge of the unfit had an opportunity, in a large number of cases, to study and determine the cause of their unfitness.

When the results found in the army were compared with those of the draft boards, the conditions were found to be startling, not only from the point of view of the present generation but even more so for future generations.

An example of the importance of correct body mechanics is shown by some of the experiences of the first troops who went to France. In order to bring the regiments of the first division up to full war strength, many volunteers were accepted who were not given as careful a physical examination as the later draftees. About 800 or 900 of these men went out on a twenty-eight hour maneuver, five hours of which were spent lying down, and the following day 138 men were sent to the hospital for backache or trouble with their feet. All of these were found to have incorrect body mechanics.

The strain of military life in France was such that a very large percentage of the 15,000 men in the twenty-sixth division were unable to perform the work required of them, and consequently were unfit for active military duty. These men were also found to have very bad bodily mechanics. Since there were no transports to take them home, and the hospitals could not look after them, they were formed into a special training battalion. A course of education in bodily mechanics, or the proper use of their bodies, was given, and in six weeks time 80 per cent. were brought up to practically full physical efficiency. If these men had had a proper physical education before they went into the army an enormous amount of time, money and useless waste could have been avoided.

Very strict rules were consequently made by the government for the first examination of the draft boards, and out of 2,570,000 men

between the ages of 21 and 31, examined by the draft boards, 29.1 per cent. were rejected on physical grounds. In other words, an army of 730,000 men were physically unfit for military service. In addition to this, when the men accepted by the draft boards were mobilized, about one quarter to one third were rejected by the military officers during the first year. This means that out of the original two and a half million draftees examined for the army 45 per cent. +, or nearly half, were rejected because of physical unfitness.

England overcame her shortage of man power during the late years of the war by taking those men who had formerly been considered unfit and bringing them up to full efficiency by a long course of training. The lack of proper education during the growing and formative periods of these men's lives not only cost the British Government a great deal of money but also much anxiety as to how to obtain the necessary man power.

In order to provide suitable education in bodily mechanics, one must understand what is good and what is bad bodily mechanics, and how to judge the same. Anatomists describe the normal human being and say there are fairly wide variations from the so-called normal. A superficial study of a large number of people will show that there are many varieties of human beings; some are relatively tall and thin, and no matter what they eat can never get fat; while others are relatively short and stocky and have a tendency to get fat no matter how little they eat. These two extremes show marked physical differences but despite this, both may be considered to be normal.

The difference in the human body is not confined to its outward shape alone. The roentgen-ray shows extremes of differences in the frame-work and also in the position and shape of the internal organs. There will also be every degree of variation between the extremes. The normal, therefore, cannot be found by taking the average of a large number of measurements of the ordinary individual since these measurements would be open to the same criticism that would apply to a series of measurements and weights of spleens of individuals who lived in a malarial country. The measurements so taken would only be the average for the people of that particular section of the country and not necessarily for the rest of the world. The standard of normality, therefore, cannot be based on averages but must be based on what is considered the *ideal* for a given type of individual. The human machine may be far from this standard and yet be very efficient. Many of our most successful men of the day are incapacitated physically but they have gained their success *in spite* of their disability.

In order to form an opinion of what constitutes mechanical perfection, it is necessary first of all to have a mental picture of the body. This picture is made up from a combined knowledge of the anatomy of the body and the mechanical changes which may come in the various positions which the body assumes; from what may happen to the internal shape of the thoracic and abdominal cavities in these various positions, and to the organs in these cavities as the cavities change their shape. It is impossible in an article of this length to give a picture of the mechanics of the body as a whole, but fortunately this is not necessary since the mechanical principles which govern a particular part or organ may be applied to the whole body. Take for example the spine. When the bones, muscles and ligaments of the spine are in a position which allow equal motion in any direction then they are being used in a position of least strain and are mechanically most efficient. When, on the other hand, they are used at one limit of their motion, they are mechanically inefficient because one group of muscles and ligaments has to do more than its normal work, and the result is strain.

This mechanical principle of using the spine at a point not at either extreme of its curves or range of motion but at some midway point can be applied to all other parts of the body. Take, for example, the chest. In the perfectly aligned human machine, the lower ribs at the axillary line in the ordinary standing position will have wide intercostal spaces. In the human machine with the bad bodily mechanics the ribs will be found to be very close together, or even over-riding. This crowded position, which can only mean strain, is a physical defect and is necessarily associated with other malalignments, such as a flat chest, a rounded dorsal spine, a forward head and a protuberant lower abdomen.

It is, of course, only possible to form an accurate opinion of the mechanics of the body by a complete examination of the body with the clothes off.

The question naturally arises, does poor posture or bad bodily mechanics have any effect on the health of the individual? In order to get some data by which to form an opinion of this kind, a careful examination was made of all men in the freshman class at Harvard University, attention being paid not only to the usual medical examination but also to the posture or the bodily mechanics of each man. A tracing was taken of each one, and when these tracings were collected and studied they were found to fall naturally into four groups which for convenience were designated, A, B, C, and D (Fig. 1). Of the 700 men examined, 7.5 per cent. were in Group A, 12.5 per cent. in Group B, 55 per cent. in Group C, and 25 per cent. in Group

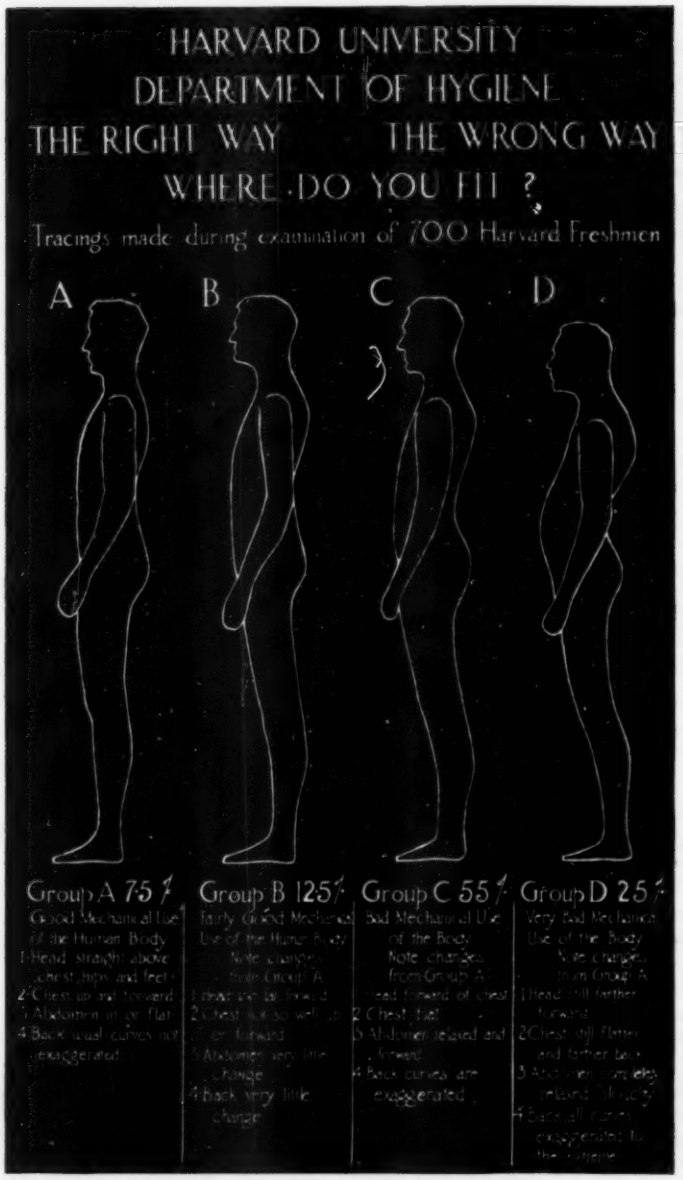
HARVARD UNIVERSITY
DEPARTMENT OF HYGIENE
THE RIGHT WAY THE WRONG WAY
WHERE DO YOU FIT ?
Tracings made during examination of 700 Harvard Freshmen
A
B
C
D
Group A 75 %
Good Mechanical Use of the Human Body
1 Head straight above chest, chin and feet
2 Chest up and forward
3 Abdomen in or flat
4 Back in just curves not exaggerated
Group B 125 %
Fairly Good Mechanical Use of the Human Body
Note changes from Group A
1 Head not so well up
2 Chest not so well up or forward
3 Abdomen very little change
4 Back very little change
Group C 55 %
Bad Mechanical Use of the Body
Note changes from Group A
1 Head forward of chest
2 Chest flat
3 Abdomen relaxed and forward
4 Back curves are exaggerated
Group D 25 %
Very Bad Mechanical Use of the Body
Note changes from Group A
1 Head still farther forward
2 Chest still flatter and farther back
3 Abdomen entirely relaxed and forward
4 Back all curves exaggerated to the extreme

Figure 1.

D. In other words, 20 per cent. of the men used their bodies in good or fairly good mechanical lines, and 80 per cent. in bad mechanical lines. The results of this classification were then compared to the medical findings which showed that no man in Groups A or B complained of backache, while over 6 per cent. in Group C and over

8 per cent. in Group D gave a history of backache. Functional albuminuria was much more common in Groups C and D, and more common in D than in C. Operations for appendicitis were progressively more common as one went from A to D. These findings strongly suggest that poor mechanical use of the body may be considered a definite factor in the health of the individual.

Poor bodily mechanics are more easily prevented and corrected in childhood than in adult life, and the time spent in training at this age brings far more reaching results than the same time spent on adults. The remainder of this paper will be devoted to the report of cases among children, illustrating some of the conditions which result from poor bodily mechanics, and the improvement which may be expected when the poor posture is corrected.

CHARACTERISTIC SYMPTOMS OF EACH GROUP

Constipation.—The symptom which characterizes the first group is *chronic constipation.* Such cases are not rare even in childhood and often the patient gives a history of consulting one physician after another without relief. In many instances large doses of laxatives are required daily, and occasionally the constipation is so severe that enemas are given daily to obtain a stool. Physical examination reveals nothing abnormal except a large abdomen and lordosis which are a part of the poor bodily mechanics.

REPORT OF CASES

CASE 1.—M. D., age 6½ years. When first seen in December, 1913, she had had digestive trouble, associated with constipatien, and a very large abdomen during the first and second years of her life. She came in at this time because of a painful hip which came on suddenly when getting out of bed one morning. The physical examination (Fig. 2) showed that she was of the extreme bad mechanical type with very large abdomen and the extreme flat chest. The hip showed only slight limitation of motion at the extremes, and did not exactly simulate a hip disease. The child was fitted to a brace to support the abdomen and the back, and was given simple exercises for the body. The hip trouble entirely cleared up and the constipation which had always been very troublesome gave practically no more trouble for two years. In 1917, she was again seen because she was badly constipated, had dark circles under her eyes, and tired very easily. She had not taken any exercise or worn her brace for many months. A new brace was applied and she was started on her exercises and rest periods again. When seen in June, 1919, she had had a very good winter; the digestion had been very good, and she was taking no medicine for her bowels.

Comment.—The interesting points in this case are the digestive disturbances, the constipation and the arthritis of the hip, all of which cleared up with the correction of the extreme faulty mechanics of the body.

The exercises referred to above and which with simple modifications were given in all the cases in this series, were planned not primarily to strengthen the muscles, which are always weak in these cases, and so get the child into better muscular tone and better posture, but to teach the correct posture of the body and then do a few exercises, provided the body was kept in good mechanical lines while doing the exercises. It was considered much more important to keep the body properly lined up than that she should be able to do an exercise or a series of exercises any great number of times or with any special rhythm.

Fig. 2.—Note the extreme faulty posture, especially the flat chest and the abdomen that is more protuberant below the umbilicus than above.

The type of brace varies with the individual. In some cases a small abdominal pad which is attached to a small back pad is used, while in others the abdominal pad is attached to a spring back brace which has shoulder straps. The type of support used depends on the condition of the child and whether or not she is able to hold herself in the correct position.

The best periods referred to are carried out most carefully because it is considered that fatigue is at the bottom of a large

amount of the bad postural conditions. The child is always made to lie down on its back with no pillow under the head. A small pillow is placed under the back so that it reaches from just above the hips to the middle of the scapulae. It is desirable to have the child take this position after each meal for at least one half an hour. After the noon meal a full hour is better than the shorter time.

Fig. 3.—Type seen in cyclic vomiting. Note the relaxed posture, especially the prominence of the abdomen below the umbilicus.

CASES 2 AND 3.—Patients, aged 5 and 3 years, respectively. These two cases are reported together because the patients were brothers and both had severe

attacks of indigestion. The elder suffered from cyclic vomiting, and the younger from extreme constipation, occasional attacks of so-called "acidosis," and from a very bad temper. The attitude (Fig. 3) of the younger brother is characteristic of both children. An abdominal support was applied in each case. Reports received two years later from the father, who is a physician, state that both children were much better, that the vomiting had stopped and the constipation had become negligible. Several attempts were made to leave the support off the younger boy, but each time without success. It was always necessary to go back to it because he became constipated, acted tired, and had very dark circles under his eyes. After wearing the support for two winters, both the boys went without it for the summer.

Comment.—In these cases, as may be expected in others, the abdominal support took enough strain off the lower abdominal muscles so that they tightened up and changed the shape of the

Fig. 4.—Note the extreme relaxed posture with the abdomen large, especially below the umbilicus.

abdomen, making it more prominent above the umbilicus than below, a condition that is found in the presence of good bodily mechanics. When this condition has been reached, it is possible to do without the support and get along with only the corrective exercises, provided that the child does not get overtired from one cause or another. When a child has once learned the correct use of its body it never forgets it, any more than a person forgets how to skate, but in order to keep in good condition it is very necessary that the exercises should be kept up in order to prevent a relapse into the position of bad posture.

Case 4.—W. L., aged 7 years, gives a history of always having been constipated and tired. Whenever he had a cold he would vomit several times at the onset, and the urine would show large amounts of acetone. His physical examination was made frequently and was always negative except that he always looked fagged out, had deep circles under his eyes, and flabby musculature. His posture was extremely poor (Fig. 4); the abdomen being prominent and relaxed especially below the umbilicus. The feet were relaxed and pronated, and there was marked lumbar lordosis. An abdominal and back support was applied and he was given corrective exercises. The constipation became less and less marked, and he grew stronger and had more vitality.

He is now in good general condition, is no longer constipated, has passed through two winters without any illnesses, and is able to meet the requirements of his life with fewer upsets. He continued to wear his support for three years.

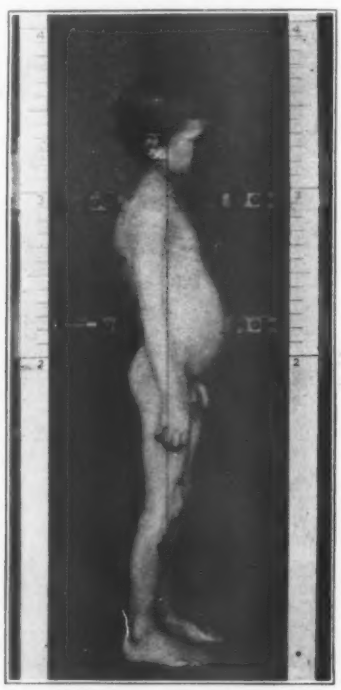

Fig. 5.—Brother of child shown in Figure 4. Note the same condition.

This length of time could have been considerably shortened if the directions for rest and corrective exercises had been more closely followed out. With the change in body posture came changes in general appearance and actions which were very striking. Although all other medical methods of treatment had been tried without any good results, improvement came very quickly after the new method of treatment was instituted.

Case 5.—A. L., aged 10 years +, gives a similar history to that of his brother (patient, Case 4). The mother described him, at 2½ years, as being "lifeless and white as chalk." He was always tired and always vomited at the onset of every infection. The physical examination at 3¾ years of age showed a very bad mechanical alignment of the body with a flat chest and a relaxed abdomen which was especially prominent below the umbilicus (Fig. 5). At the time of

the first examination he was given only some simple instruction in the proper way to use his body. The following year, when seen again, the mother said that he had had an excellent summer, but since returning to the city and going to school he had been getting progressively more tired and fussy. He had lost all he had gained by his exercises because they had been given up. A spring brace was, therefore, applied and new instructions given in the proper use of his body. The last examination, at 10 years of age, showed that the boy had a large chest with firm muscles, but he still stood in a very relaxed position which he could correct very easily. He no longer looked fatigued and was better able to stand the stress of city life. As in Case 4, the correction of the extreme faulty mechanics by the brace and the relief from strain which the brace gave, prevented the overfatigue which had previously handicapped him, and made it possible for him to develop normally.

It was interesting to note the general improvement in all these cases after the application of the anteroposterior pad and back brace. When the strain was relieved the children immediately became better natured and happier, played with greater zest, and were less nervous and irritable. After supplying the supporting belt, the constipation also showed immediate improvement for about two weeks and then relapsed, after which it improved until finally it was entirely cured and normal evacuations of the bowels obtained without the use of any drugs.

These cases are examples of the type of individual who is constipated for years, tries one physician after another without success, and if left to themselves will live a "dragged out" existence, depending on laxatives for any well-being at all. Correction of the bodily mechanics may be expected to save the patients many years of poor health and give them normal bodily vigor.

Cases 6, 7, 8, 9 and 10 are illustrative of cyclic or recurrent vomiting. All of these patients were first treated by the usual dietetic methods with some improvement but without cure. Drugs and alkalies did not prevent the recurrence of the attacks, and it became clear that some other factor than diet played a part in the production of symptoms. They were finally treated from the point of view of faulty bodily mechanics and ptosis with the following results.

Case 6.—A. W., a boy, was first seen in 1916 at the age of 5 months. After weaning he was tried on modified milk and had a convulsion accompanied by a good deal of colic and gas. The physical examination at that time was normal. A wet nurse was obtained and the child did well. The following year, at the age of 16 months, he was seen because of repeated stomach upsets and constipation with constant presence of gas in the bowels. The stools then showed a tremendous amount of fat under the microscope. The symptoms improved by reducing the amount of fat in the food, but he continued to be constipated and required a laxative each day. In March, 1917, at the age of 1½ years, the physical examination showed a well nourished child with flabby flesh and somewhat pronated feet. A bismuth roentgenoscopy showed a large stomach containing an unusually large gas bubble, and a great deal of gas in the colon. The examination was unsatisfactory because of the age of the child and his inability to hold the enema. The transverse colon was seen to be of the hammock type. The point of special note was that the abdomen was very large and was most

prominent below the umbilicus. An abdominal belt of cloth was applied which was to be worn temporarily night and day. A report a month later said that there had been a great deal of improvement. In May, 1920, at the age of 4½ years, he had been free from attacks for more than a year and a half, had dispensed with the belt, and was developing like any normal child.

CASE 7—B. W., female, aged 5 years, 7 months, illustrates a condition in which vomiting was a much more severe symptom. She had had no illnesses until August, 1916, when she was 2 years old. She then commenced to have attacks of recurrent vomiting, the first in 1916, followed by others in June and August, 1917, and a severe attack in May, 1918. From then on she had attacks once in three months, which lasted about four days. At first the child vomited a little slimy material, after which she vomited whatever was taken by mouth. The bowels were usually cleared out with calomel and at first hard stools were started. Even though she took no food for three or four days, she had a large sized stool by enema each day. Between attacks the child was a very hearty eater and was troubled with constipation. A roentgen-ray report showed that the stomach was normal in outline but rather large. There was definite delay in emptying, but there was no marked abnormality in position of stomach or colon. The roentgenogram did not show any marked ptosis and ruled out obstruction in the region of the appendix, which was freely movable.

The physical examination showed an extremely relaxed posture with the shoulders drooped and the head forward. The chest was very flat and narrow anteroposteriorly. The lower ribs were somewhat flared outward. The abdomen was large and flabby and protuberant below the umbilicus. When the child lay on her back the lower ribs flared out and became very prominent, showing a partially fixed deformity due to faulty posture. Feb. 28, 1920, the family reported that after the application of the belt, March, 1919, she made a steady improvement. The abdominal support has had to be changed once or twice, but the improvement has been constant. She has had two or three attacks since last seen, but they have been less severe, the last one lasting one day instead of four. She has gained in weight and looks much better.

May 27, 1920, the mother reported that the belt was taken off after nine months and since then has not been worn. She has had no attacks since November, 1919.

Comment.—This case presents a finding which is common to many other cases in that the stools contained excessive amounts of fat. Careful dieting and reduction of the fat resulted in some improvement but not in an entire cure of the symptoms. Application of the belt for nine months, plus the corrective exercises, apparently resulted in a complete cure, and there has been no attack in the last six months.

CASE 8.—E. M., a girl, first seen in December, 1917, at the age of 5 years, with a history of having vomited for four days. The vomiting was so severe that a surgeon was called in and confirmed the opinion that the appendix was not involved. Her urine at that time contained much acetone. She did not fully recover from this, and had one severe attack and two less severe ones between then and Jan. 12, 1918. In the second of these attacks she screamed with pain in the abdomen and vomited for twenty-four hours She had been constipated for some time even though her diet had been regulated. The stools were large and sometimes light colored. The attacks were repeated frequently without any special cause, but were more apt to come on when the child was tired or excited. The physical examination showed a thin type of child standing in an entirely relaxed position without the extreme deformities one might expect (Fig. 6). The points of special note were that the abdomen was most prominent below the umbilicus and that the lower ribs at the sides were very close together and flattened in front. An anteroposterior pad was applied,

the correction of the faulty posture explained, and exercises and rest periods advised. Two years later, in the spring of 1920, her parents reported that she had been free from vomiting and pain since the belt was fitted.

Comment.—This case illustrates the difficulty in determining whether in the presence of abdominal pain, a surgical condition is back of the trouble or not, and should be contrasted with Case 11. In an earlier part of the paper the increased incidence of abdominal operations in

Fig. 6.—Thin type of child standing in entirely relaxed posture without extreme deformities one might expect. Note the relaxation of the lateral walls of the abdomen below umbilicus.

students with faulty posture was mentioned and brings up the question as to whether bad bodily mechanics does not predispose to infection of the appendix, or cause symptoms simulating those of appendicitis which result in the unnecessary removal of the appendix. The entire cessation of attacks after the application of the belt was very striking, especially as it came out at an age when a spontaneous cure could not have been expected.

CASE 9.—G. M., aged 5½ years, brother of patient, Case 8, had stomach upsets similar to his sister. (His mother says that she herself used to have "bilious attacks" as a child, but has outgrown them.)

He was always well up to the age of 2 years, when he commenced to have attacks of vomiting in which he would vomit for three days at a time, being even unable to retain water. These attacks would return about once in six weeks. During the attacks the eyelids often swelled up following the administration of large amounts of sodium bicarbonate given because of acetone in the urine. His stools contained a slight excess of fat between attacks. The diet was carefully regulated, and only small amounts of fat were allowed. He frequently had gas and hiccoughs and a slight cold or fatigue would bring on an attack.

Fig. 7.—Brother of patient shown in Figure 6, taken after wearing the belt for eight months (see text). Note that the abdomen below umbilicus is not as prominent as above.

The physical examination March 28, 1917, when he was 2½ years old, was difficult to make because the child would not allow his mother to take off his clothes. It showed, however, a large red cheeked boy with markedly relaxed feet and an unusually large abdomen which could be felt through the clothes, the part below the umbilicus being the most prominent. Eight months later the examination was made without difficulty and the accompanying photograph (Fig. 7) was taken. This shows the typical posture and also that since wearing the belt the lower abdomen had become much smaller and the upper part relatively larger, a condition that one would expect to obtain with wearing a belt. After applying the belt, April 12, 1917, he had no more attacks, and has now been free from vomiting for over two years.

Comment.—This case illustrates the fact that there is a tendency for poor body mechanics to run in families. Like his sister, cure followed the application of the belt.

CASE 10.—J. G. suffered from recurrent vomiting and recurrent diarrhea with marked malnutrition. She was first seen in 1914 at the age of 6 years, with a history of repeated attacks of vomiting of all food, sometimes accompanied by rise of temperature and acetone in the urine. Occasionally, the attacks would end in a mild colitis in which the stools contained mucus and at times blood. Recovery from the attacks was slow. The attacks came on at intervals of from three weeks to four months without any known cause. The physical examination was normal, aside from the fact that she was poorly developed and badly nourished with a shallow chest and a protuberant and relaxed abdomen (Fig. 8).

Fig. 8.—Thin type of child markedly relaxed with lower ribs flared outward. The abdomen very large below the umbilicus.

A roentgenogrm in 1914 showed that there was a large dilated atonic stomach, a greatly distended large intestine with ptosis, but no evidence of adhesions.

In January, 1914, at the age of 6 years, she was fitted to a belt and given the usual rest periods. She was on an entirely fat-free diet. After the belt was applied, she improved somewhat, but continued to have attacks every two or three weeks of vomiting and diarrhea lasting several hours and always accompanied by the presence of acetone in the urine. After a while, the intervals between attacks became longer and the vomiting less frequent and severe, but she still had slight upsets during which her breath and bowels would not be just right. Between the attacks she was very constipated. During the next year,

1915, she did not gain much in weight, but her appetite became better. After 1916 she had no more attacks of any kind and gradually commenced to do the things normal for her age.

March 11, 1920, a letter was received from the mother stating that she had done finely during the past year and had grown tall and quite stout.

Comment.—This case is interesting because after the anteroposterior pads were first applied and the proper resting positions and exercises were given, she improved and was not seen again for four years. The recurrent vomiting and diarrhea had been controlled entirely, presumably because she had persisted in the exercises and followed all directions to the letter thereby preventing overfatigue and giving her body an opportunity to compensate for the defects due to the bad bodily mechanics.

These five cases are examples of different types of cyclic vomiting all having the same physical background, faulty bodily mechanics. When these children are undressed, the relaxed abdomen, particularly prominent below the umbilicus, immediately strikes the eye. A careful study of cases of cyclic vomiting, many of them in retrospect, makes it seem probable that these children have what might be termed fractional constipation due to a lax intestinal and abdominal wall. This condition is undoubtedly accentuated by fatigue. Even though they have a movement of the bowels each day some fecal material is left behind, which gradually accumulates to a degree which causes vomiting. In two cases seen before the present method of treatment was instituted, the vomiting persisted until the children had a tremendous evacuation of the bowels, after which they sat up in bed and said they were well. Subsequent treatment and results showed that they were right.

CASE 11.—This case illustrates a condition which is not uncommon and which may be confused with cyclic vomiting, but which needs surgical interference.

D. C., a girl, aged 4½ years, had her first attack of vomiting when she was 4 years old. Following this she had two other attacks which made it seem probable that she was commencing to have recurrent vomiting. The physical examination was normal. After three days of vomiting her abdomen was sunken and easily palpable everywhere, and there was no dullness, tumor or tenderness. On standing, the abdomen seemed to be relaxed. A belt was, therefore, put on and she was given exercises. The fat in her food was reduced because her stools showed a slight amount of fat, but despite the abdominal support, the attacks of vomiting continued.

Subsequently, roentgenoscopy showed dilatation of the small intestine just above the ileocecal valve and the large intestine practically empty. This was interpreted as evidence of obstruction at the ileocecal valve due to a diseased appendix. The operation showed a chronic appendix with adhesions

Comment.—This case brings out two points, first, that in all cases of recurrent vomiting the possibility of a chronic appendicitis must be ruled out, and, secondly, when there is inflammation of the appendix, abdominal support cannot be expected to affect it favorably.

The third group of cases illustrates the symptom complex of chronic constipation associated with attacks of severe abdominal pain. In some of the cases, there was vomiting which was so alarming that in two of them abdominal operations were considered, and in the third case an operation was performed for acute intestinal obstruction. The histories of these cases are similar to those of the preceding group, except that in the one vomiting was the prominent symptom and in the other the abdominal pain.

Case 12.—E. S., a girl, was first seen at the age of 13 months. She was a normal child at birth and was breast-fed for five months. After that she had a difficult feeding history in which the prominent symptom was constipation with large amounts of gas in the bowels. At one year, she commenced to have attacks of violent pain in the abdomen. The stools showed a large excess of fat under the microscope and she was, therefore, put on a diet with part of the cream removed from the milk, but still continued to have considerable gas in the bowels which caused her to wake up from a sound sleep crying. She was also habitually constipated. The mother came to the conclusion that if the bowels were not moved they would finally block up and cause an attack of pain with fever and vomiting, the attacks coming at intervals of from two to three months. During the attacks the stools were usually undigested and contained an excess of fat with much mucus in spite of the fact that some of the cream was removed from the milk. During the second year she had four or five such attacks, at the end of which time a cloth belt was applied because of her protuberant lower abdomen. After this she became somewhat less constipated, but still required a laxative. She continued to improve in general condition, looked better, and went through several respiratory infections without vomiting or attacks of pain. Oct. 29, 1917, a spring back brace was applied because of the continued constipation, after which she was much better. From then on up to date, that is, in the last three years, she has had no more attacks of pain or digestive upsets, although she has been through several illnesses.

Comment.—This case is interesting because it is an example of a child who developed symptoms at a very early age, 13 months, before the upright standing position could be expected to play a part in the body mechanics. It illustrates further that it is practical to apply a belt at a very early age.

Case 13.—L. B., a girl, commenced to be constipated at 4 months of age. She was found to be unable to digest cream. At 5 years of age she complained of headache off and on. At 5½ years she had an attack of indigestion with a temperature of from 99 to 100 F., and she was nauseated and cried because of severe abdominal pain. Enemas brought away considerable gas, but no feces; they gave temporary relief from the pain. Her physical examination was normal, except for gas and tenderness in the lower bowel. The continued abdominal pain suggested an acute appendicitis, but the surgeon who saw her in consultation did not think that the appendix was the source of the trouble. In the next few days the stools contained large amounts of mucus with a small amount of fecal material. The pain then gradually disappeared. During the next six months she had two more attacks of pain, looked pale and run down, and was found to have pus cells in the urine. The pyelitis resolved itself, but the constipation continued, and in the fall of 1914 she had another attack of severe abdominal pain with gas, which was relieved by an enema. At this time it was noted that she had a shallow chest and a large relaxed abdomen (Fig. 9).

In December, 1915, a spring back brace was applied. She wore it for six months, at the end of which time the brace was dispensed with and an antero-posterior pad was applied. The constipation gradually disappeared during this time and she had no more attacks of pain. She has now been well and without treatment for over four years.

CASE 14.—E. S., a boy, when 2 years old commenced to cry out in the middle of the night for no apparent cause, following which he would have attacks of high temperature. At that time he had what was said to be a fat indigestion and the fat in the food was reduced with immediate improvement. In 1912, when he was 3 years old, he had grip with otitis media followed by enlarged glands in the neck, which eventually broke down and were thought to be tuber-

Fig. 9.—Note the extreme faulty posture with the very large abdomen which is most prominent below the umbilicus. Note also the forward position of the head, flat chest, and the increased curves of the back.

cular. This, however, was not proven. In 1914 he was very constipated and was given Russian mineral oil, which resulted in satisfactory movements of the bowels, and he became better and gained weight.

Jan. 20, 1917, he had a sudden attack of severe abdominal pain and nausea. The pain was in the left upper quadrant of the abdomen and was relieved temporarily by a laxative and the passage of much gas. From then until January 23, he continued to have pain. On the twenty-third he suddenly sat up after a movement of the bowels and said he was well. In February, 1917, he had another similar attack of pain lasting two days, with a temperature of 99 F. March 5 and 6 he had a third attack of pain with a temperature of

102 F. Enemas were given on all of these occasions and brought away much fecal material and gas, after which the symptoms were relieved. March 8 and 9 he had a mild attack. Roentgenograms showed that he had a redundant colon with a loop in the splenic flexure, which came down two-thirds of the way to the sigmoid.

A physical examination showed a very delicate boy with bright red cheeks. His posture was that of complete relaxation with a very large bloated abdomen. In spite of the size of the upper abdomen, the lower abdomen was even more prominent. The abdominal musculature was negligible because it had been stretched out as a result of the distention. The lower ribs were very much flattened and flared outward. An anteroposterior pad was applied for day wear and a webbing belt for night wear. There was also ordered a very careful routine of rest to be taken in special positions to correct the faulty mechanics as well as to keep him quiet. The importance of the rest in these cases cannot be overemphasized.

The attacks of pain were relieved somewhat, and finally became less frequent and severe, and he commenced to gain in weight and have very large movements of the bowels. During the summer of 1918 he had pain off and on in the left upper quadrant. A new brace was fitted in October, and the attacks of pain finally stopped entirely in January, 1919. From then on his convalescence has been uneventful and for the past year and a half he has been considered a normal boy.

Comment.—This case is an example of recurrent attacks of pain in the splenic region with vomiting and symptoms simulating obstruction. The symptoms were so severe that two internists and a surgeon thought that an exploratory operation should be performed. It was not until the mechanical element was taken into account and an abdominal support was given that relief was obtained. This case also illustrates the point that the wearing of a support by patients who have a large distended abdomen, even though the child is in bed, will relieve a serious and painful condition.

Case 15.—H. C., a boy, was first seen in July, 1916, at the age of 11 years, with the following history:

At 3 years he had an acute attack of diarrhea which was probably an infectious diarrhea. At 5 years he commenced to have attacks of abdominal pain with symptoms of intestinal obstruction which were thought to be due to a recurrent appendicitis. He was operated on at this time and found to have a definitely chronically inflamed appendix with adhesions of the ileum. After this he was perfectly well for a time, but the attacks returned again at the end of six months. The attacks always followed overeating, mental or physical fatigue, and were accompanied by pain and sometimes nausea. The pain during the attacks was so severe that it caused him to cry out and his face to break out in perspiration, but it was not necessary to use opiates. The boy found that the pain was relieved somewhat if he tied a towel tightly around his lower abdomen during these attacks. When the bowels were thoroughly cleaned out the abdominal symptoms would disappear.

The intervals between attacks then lengthened out and he was having only one attack every six months, until the year previous to his visit to me when the attacks again increased in number and in the last three months, that is, since April, 1916, he had been having one attack after another. The last of these attacks simulated acute intestinal obstruction and he was, therefore, operated on again. Previous to this attack he had been on a very strict diet of which no criticism could be found. At this operation there were found to be adhesions in the neighborhood of the appendix. The lower part of the small intestine

was found to be normal in every way, but as it was followed up there was dilatation as large as the wrist. This condition included about half of the small intestine. The mesentery over a large part of the small intestine was full of small glands, none of which, to the eye, showed any evidence of tuberculosis. There were a few glands in the region of the cecum which increased in number up to the region of the ligament of Trietz, where there were sheets of glands, the largest being the size of a bean. None of the glands were excised and nothing was found which led the surgeon to believe that there was any mechanical cause for the upset.

When seen one month later, July, 1916, his physical examination did not show anything remarkable aside from the operation scars and the fact that the lower abdomen was protuberant and apparently relaxed. The stools at this time contained a large excess of fat. The diet was, therefore, regulated accordingly.

In the fall of 1916 an abdominal pad was applied to the lower abdomen. He made a slow gain in weight and instead of being constipated and using considerable Russian mineral oil daily his bowels moved regularly with the use of an occasional cathartic, his flesh became firmer, and he was having no attacks of pain.

In February, 1917, he had an attack of grip and slight pain in the abdomen. He was then well until February, 1918, when he had an attack of diarrhea and considerable pain in the abdomen, which was relieved by passing gas and bloody stools.

In June, 1918, he was doing very well and having very little pain. In March, 1919, he reported that he had had an exceptionally good winter, with only two slight upsets, both of which followed eating food at boarding school which caused the other boys also to have digestive upsets. During most of this time he had been wearing the abdominal support. He found that when there were any signs of discomfort the belt relieved the symptoms very quickly.

During the past year he dispensed with the abdominal support and has been free from the attacks of pain.

He is now 16 years old (1920), takes slight part in athletic sports, rides horseback, and with a little more careful diet than most boys of his age, lives a normal life.

Comment.—This case illustrates a situation in which everything that was possible surgically was done for the boy, but despite this the attacks of pain recurred with equal severity until the abdominal support was applied, and both the parents and the boy are convinced that the belt is responsible for his well being. He says he is able to prevent the recurrence of symptoms by putting on the belt at the earliest premonitory sign.

SUMMARY

1. Faulty bodily mechanics was responsible for a great loss of efficiency among adults in the war.

2. Correcting it, changed many inefficient men into efficient soldiers.

3. It is common to all ages and is surprisingly prevalent.

4. It is easily corrected and can be done so most economically during childhood.

5. It is responsible in most instances for diminished powers of digesting fat in children.

6. It is the cause of a certain amount of chronic constipation.

7. It is the background and probably the cause of many if not most cases of recurrent vomiting.

8. In many instances the symptom of acute abdominal pain in children, when associated with chronic constipation, is due to poor bodily mechanics. These symptoms are often so severe that they are confused with those of acute intestinal obstruction due to other causes.

9. In the cases cited in which the faulty body mechanics have been corrected, in connection with the other treatment, the patients have all shown a more speedy recovery than is seen in cases without this correction. This makes us feel that the element of body mechanics is one which should always be considered in these types of cases.

THE CIRCULATORY REACTIONS TO GRADUATED EXERCISE IN NORMAL CHILDREN *

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INTRODUCTION

Recent experience at the army camps has demonstrated the importance of physical training in the adult. We know that exercise is necessary for normal children, since it is indispensable for proper development of the skeletal muscles, the heart and lungs; and latterly the medical profession has come to appreciate that exercise is also important for children with chronic valvular disease. It is very difficult to decide on the amount of exercise to be allowed a patient with cardiac disease. The subjective symptoms and objective findings following given exercise have been depended on to determine the "exercise tolerance." Individual interpretation of clinical symptoms in children is naturally limited and variable, and here it also must be remembered that there is a certain element of error in a child's estimate of its subjective sensations following exercise. For these reasons, any additional facts in estimating the "exercise tolerance" would be of great value.

Bainbridge [1] states that the range of a man's ability to take exercise is usually determined by the functional capacity of his heart. Although exercise taxes the resources of the circulatory and respiratory systems equally with those of the muscles, the heart, as a rule, reaches the limit of its powers earlier than the skeletal muscles, and its functional capacity determines a man's capability for exertion.

According to Mackenzie,[2] the functional efficiency of the heart muscle depends on the reserve force, and exhaustion of this reserve force may be physiologic or pathologic, both more or less alike, except that the latter occurs with greater facility. Most of the tests of the function of the heart in adults are based on the circulatory

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* Read before the Section on Diseases of Children of the American Medical Association at the Seventy-First Annual Session, held April 26-30, 1920, at New Orleans.

1. Bainbridge, F. A.: The Physiology of Muscular Exercise, Longmans, Green & Co., pp. 3 and 187.

2. Mackenzie, Sir. J.: Principles of Diagnosis and Treatment in Heart Affections, Henry Froude, Oxford University Press, 1916, p. 40.

Figure 1

Figure 2

Figs. 1 and 2.—Movements during test exercise. The dumbbells are swung from the floor to the full stretch of the arms overhead, describing an arc, and back again between the legs. There is no pause between the up and down motion, or between the swings.

changes produced by muscular exertion. Such changes of pulse rate and blood pressure have been considered to be important criteria of the heart's function.

Reports in the literature of the circulatory reactions after exercise in children are limited to change of pulse rate, since heretofore estimation of blood pressure in children has not been considered to be of clinical value, and a review of the literature does not show any work on the circulatory reactions after exercise in children, similar to that of Barringer [3] and Cotton, Rapport and Lewis.[4]

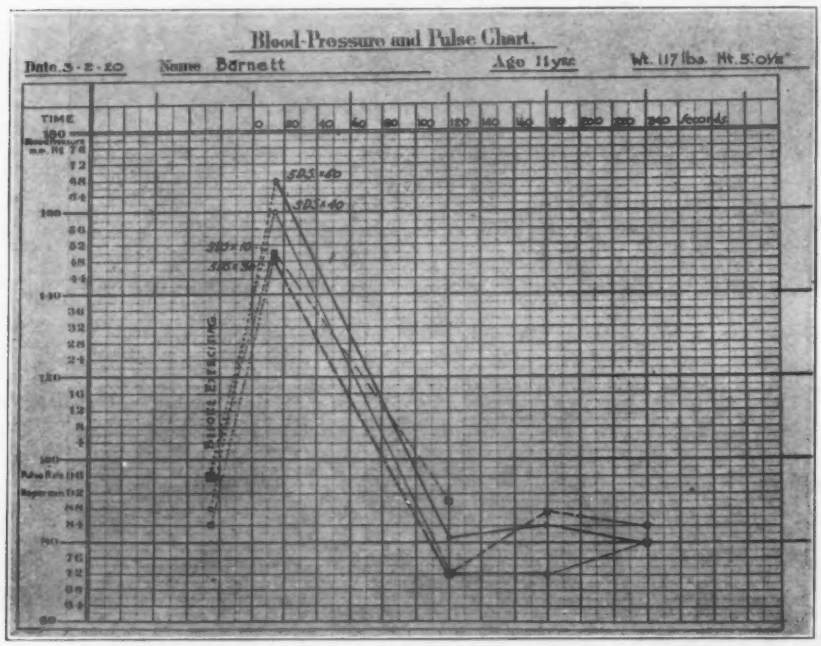

Fig. 3.—Chart of typical curves of pulse immediately following series of increasing amounts of exercise, at a constant rate of two seconds per swing. Two 5-pound dumbbells swung ten, thirty, forty and fifty times. Zero line represents end of exercise.

The present study was, therefore, undertaken to ascertain whether the circulatory reactions after exercise in normal children were similar to those found in adults, and whether in these reactions anything can be found to act as a guide or check in estimating the "exercise tolerance."

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3. Barringer, Theodore B., Jr.: Studies of the Heart's Functional Capacity, Arch. Int. Med. **20**:829 (Dec.) 1917.

4. Cotton, T. F., Rapport, D. L., and Lewis, T.: After Effects of Exercise on Pulse Rate and Systolic Blood Pressure in Cases of "Irritable Heart," Heart, **6**:269, 1917.

TECHNIC

Similar experiments on circulatory reactions after exercise in normal adults, reported by Barringer and Cotton, Rapport and Lewis were closely followed. My investigations were conducted on twenty average normal children between the ages of 6 and 13, sixteen boys and four girls. Repeated observation of pulse rate, systolic blood pressure and clinical symptoms following the termination of graded test exercises were noted on each child. The period of observation was from two to eight weeks, at two day intervals. In all, more than five

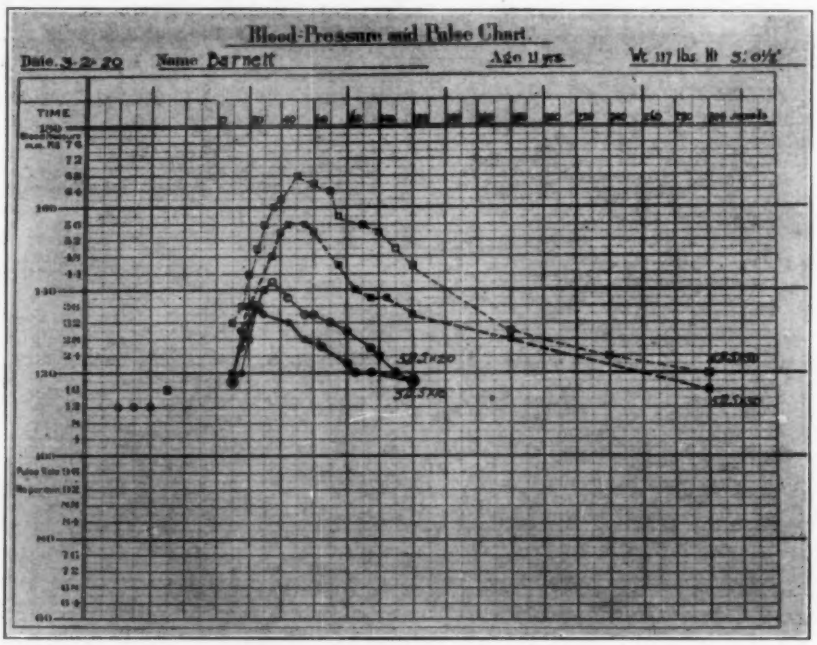

Fig. 4.—Chart of typical curves of systolic blood pressure reactions immediately following exercise as described in Figure 3. Controls noted to left of zero line; work to right of curves.

hundred individual test exercises were given, comprising one hundred and fifty complete experiments; each experiment consisted of three or four graded test exercises.

The test exercises consisted of swinging one or two iron dumbells (3, 4, 5, 7 and 10 pounds each) from the floor to the full stretch of the arms overhead, and back again between the legs, *at a constant rate of two seconds for each swing* (Figs. 1 and 2). This movement was repeated from ten to sixty times to increase the amount of work. Each child performed at one visit three or four of these exercises, graded from moderate to severe, until the *maximum* effort was

approached, as evidenced by marked breathlessness, flushed face, perspiration and fatigue. This was corroborated by an additional exercise of slightly increased intensity. The possible influence of one exercise on another was eliminated by allowing a full rest between each exercise, and by varying the order of the exercises on subsequent visits. The pulse rate at the wrist was taken by an assistant before each exercise until it remained constant. It was then taken immediately after exercise for fifteen seconds, and again at the end of one hundred and ten seconds after exercise, for twenty seconds. From

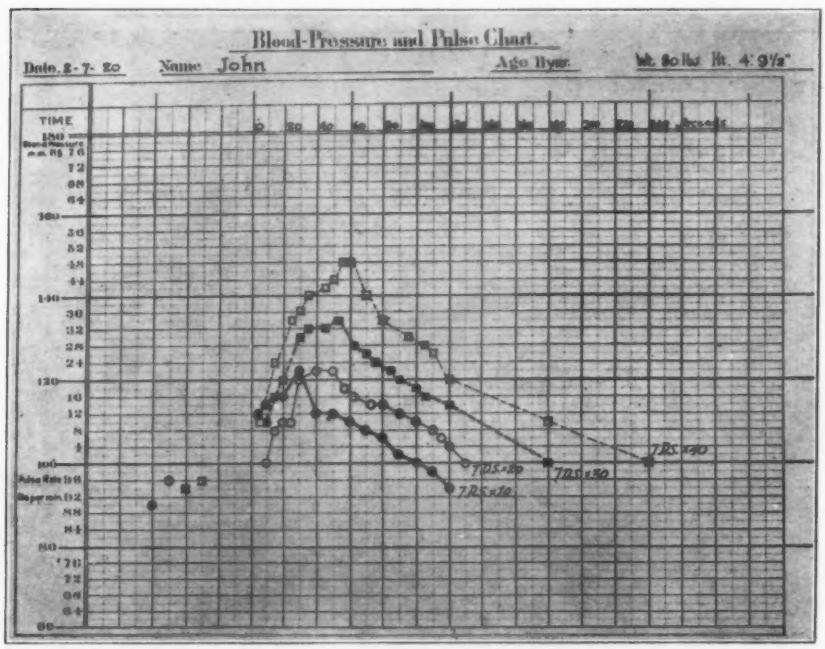

Fig. 5.—Chart of typical curves of systolic blood pressure reactions following series of increasing amounts of exercise, at a constant rate of two seconds per swing. Two 7-pound dumbbells swung ten, twenty, thirty and forty times.

these counts the rates per minute immediately after exercise, and at the end of two minutes, were calculated. A pulse rate within six beats of pre-exercise rate was considered normal. If the pulse did not reach normal at the end of two minutes, it was taken at half-minute intervals for from three to five minutes.

The method used to obtain the systolic blood pressure curve following exercise was that of frequent readings at five and ten second intervals as described by Rapport. In some instances, the method of infrequent readings as described by Barringer was utilized. The instrument used was an accurate mercury sphygmomanometer, with a

9 cm. child's leather cuff, which remained on the arm during exercise. The blood pressure readings were taken by auscultation with the child in a sitting posture (Fig. 3). The systolic pressure was read before exercise until a constant level was reached and at frequent intervals for two minutes as a control, to eliminate possible variations due to cuff pressure. To obtain early readings of systolic pressure immediately after exercise, the child was instructed to sit down quickly and quietly, the plug was inserted into the cuff, and the first pressure read within ten seconds; and subsequently, at intervals of five seconds, until a maximum reading was obtained. Later, readings were taken at ten second intervals until the reading was within six millimeters of normal. No difficulty was experienced in obtaining early readings without the use of the apparatus described by Rapport.[5] The assistant noted the time exercise ceased, and the time the readings were made.

CIRCULATORY REACTIONS AFTER EXERCISE

1. *After Effect of Exercise on Pulse Rate.*—Immediately after exercise the pulse rate was markedly increased, the rise being between five and one hundred beats per minute; the maximum rate recorded was 174. In 63 per cent. of the experiments, the rise of pulse rate was apparently proportional to the increase of work performed; in 60 per cent. the maximum rate accompanied the maximum amount of work. In 57 per cent. of the experiments, the time required to reach the normal was two minutes; in 28 per cent. the pulse dropped below the normal at the end of two minutes. In 13 per cent. the pulse was above normal at the end of two minutes. It is rather surprising to note that in the majority of the experiments following maximum effort, the pulse reached normal within two minutes in spite of symptoms of marked dyspnea and fatigue, so that the "exercise tolerance" in these experiments could not be determined from the pulse rate (Fig. 3).

2. *After-Effect of Exercise on Blood Pressure.*—Normal curves of systolic pressure following immediately after moderate test exercises which are performed with ease and without subsequent dyspnea or fatigue show a steep rise a little above resting level, reaching its maximum or summit within from twenty to forty seconds, and falling quickly to pre-exercise level within two minutes (Fig. 4). Curves of systolic pressure following immediately after the severest test exercises, where the limit of effort is approached, judging from the degree of dyspnea and fatigue, show an increased rise with a prolonged period of rising, or a delayed rise or summit, reaching its maximum after from fifty to seventy seconds, and falling slowly to pre-exercise level within from three to five minutes (Fig. 5). This type of curve

5. Rapport, D. L.: Arch. Int. Med. **19**:981 (June) 1917.

Circulatory Reactions After Exercise in Twenty Normal Children

Subject	Test Exercise: Swinging Dumbbells			Systolic Blood Pressure							Pulse				Dyspnea	Flushed	Pallor	Vertigo	Fatigue
				Before Exercise, Mm	After Exercise						Before Exercise, Rate	After Exercise							
	No. of D. B.	Wt. of, Lbs.	Swings, No. Times		First Reading, Mm.	Time of in Sec.	Maximum Reading, Mm.	Time of in Sec.	Rise, Mm.	Return to Normal in Sec.		Maximum Rate	Rise	Return to Normal in Sec.					
W. (1)																			
Boy, 7 yrs.	2	5	10	90	100	10	108	30	18	120	84	104	20	120	..	+			
Wt., 57 lb.	2	5	30	88	108	10	122	55	34	240	84	102	18	120	++	++	..	..	+
Ht., 47 in.	2	5	40	88	100	7	128	80	40	260	72	120	48	120	++++	..	++	+	+++
J. (2)																			
Boy, 9 yrs.	2	7	10	90	100	8	110	40	20	120	84	132	48	120	..	+			
Wt., 70 lb.	2	7	30	94	100	10	116	35	22	180	84	160	76	120	+	++			
Ht., 54 in.	2	7	30	96	100	10	128	50	32	240	84	162	78	120	+++	++	..	..	+
	2	7	40	90	108	8	130	70	40	300	96	152	56	120	+++++	..	++	+	+++
J. (3)																			
Boy, 11 yrs.	2	7	10	90	112	5	122	30	32	120	92	132	40	120	..	++			
Wt., 80 lb.	2	7	30	94	110	10	134	55	40	180	84	104	20	140	+++	+++	..	..	++
Ht., 57 in.	2	7	40	94	110	8	148	60	54	240	84	124	40	140	++++	..	+	+	+++
V. (4)																			
Boy, 10 yrs.	2	7	10	100	118	15	118	15	18	120	80	140	60	120	..	++			
Wt., 82 lb.	2	7	20	104	110	10	134	50	30	180	82	150	68	120	+++	+++	..	..	+
Ht., 52 in.	2	7	25	104	110	5	144	55	40	240	80	156	76	120	+++++	..	++	+	++
J. (5)																			
Boy, 12 yrs.	2	7	10	118	130	10	134	30	16	120	100	148	48	120	+	++			
Wt., 66 lb.	2	7	20	118	122	10	146	50	28	180	90	144	54	120	++++	+++			
Ht., 52 in.	2	7	30	120	140	10	160	52	40	240	100	168	68	180	++++++	.	+	+	+++
W. (6)																			
Boy, 6 yrs.	2	3	10	88	90	10	106	30	18	120	80	112	32	120	..	++			
Wt., 55 lb.	2	3	30	94	98	10	110	50	16	180	80	132	52	120	++++	+++	..	..	++
Ht., 43 in.	2	3	40	100	102	10	124	60	24	240	88	128	40	120	+++++	..	..	+++	+++
P. (7)																			
Boy, 11 yrs.	2	5	10	108	112	10	120	25	12	120	84	108	24	120	+	+			
Wt., 65 lb.	1	10	20	110	110	10	132	55	22	240	84	120	36	120	+++	++			
Ht., 51 in.	1	10	40	108	110	10	152	80	50	300	84	152	68	120	++++	..	++	..	++
J. (8)																			
Boy, 10 yrs.	2	5	10	108	100	10	136	40	28	160	88	120	32	120	+	++			
Wt., 83 lb.	2	5	30	108	110	10	150	55	42	200	88	144	56	120	++++	+++	..	..	+
Ht., 51 in.	2	5	40	112	118	10	152	70	40	300	88	160	72	160	++++++	..	++	+	+++
B. (9)																			
Boy, 11 yrs.	2	5	10	112	118	10	136	25	24	120	96	152	54	190	..	++			
Wt., 117 lb.	2	5	30	118	122	10	146	47	28	180	84	124	40	120	+++	++			
Ht., 62 in.	2	5	40	118	120	10	158	60	40	300	80	148	68	120	+++++	..	+	++	++
	1	10	40	116	120	10	156	65	40	300	84	144	60	120	+++++	..	+	++	++

B. (10)																			
Girl, 10 yrs.	2	4	10	92	94	10	102	30	10	120	96	120	24	120	..	+			
Wt., 76 lb.	2	4	30	96	100	10	114	55	18	180	96	156	60	120	++++	+++	..	..	+
Ht., 52 in.	2	4	40	96	100	10	128	60	32	240	88	160	72	120	+++++	..	..	+	+++
C. (11)																			
Girl, 6 yrs.	2	4	10	90	94	5	100	15	10	120	104	128	24	120	..	+			
Wt., 60 lb.	2	4	20	94	84	5	108	35	14	120	100	152	52	120	+	++			
Ht., 48 in.	2	4	30	94	100	10	124	50	30	240	116	160	44	120	+++	..	+	+	+
	2	4	40	98	108	5	128	55	30	240	108	180	72	120	++++	..	++	++	++
M. (12)																			
Girl, 8 yrs.	2	4	40	92	104	10	136	75	44	300	92	144	52	120	++++	..	++	++	+++
Wt., 62 lb.	2	4	30	90	106	5	134	60	44	300	92	146	52	120	++++	..	+	+	+
Ht., 50 in.	2	4	20	96	92	5	124	45	32	180	100	132	32	120	+	++			
	2	4	10	96	100	10	112	30	16	120	96	124	28	120	..	+			
R. (13)																			
Boy, 10 yrs.	2	7	10	96	96	10	102	35	6	120	84	120	36	120	..	+			
Wt., 74 lb.	2	7	30	96	98	10	114	50	18	180	84	156	72	120	+++	+++			
Ht., 53 in.	2	7	40	96	92	10	114	75	18	240	84	156	72	120	+++++	..	..	..	++
H. (14)																			
Boy, 12 yrs.	2	5	10	118	122	10	142	25	24	120	88	120	32	160	..	+			
Wt., 81 lb.	2	5	20	116	124	10	148	40	32	160	80	152	72	120	+	+++			
Ht., 58 in.	2	5	30	114	122	10	154	50	40	240	84	172	84	120	++++	+++			
	2	5	40	110	118	10	160	50	50	260	84	152	68	120	+++++	..	++	++	++
J. (15)																			
Boy, 11 yrs.	2	7	30	98	100	8	118	35	20	120	72	156	64	140	+	++			
Wt., 81 lb.	2	7	40	102	104	10	124	50	22	180	72	160	88	120	++	+++	..	..	+
Ht., 58 in.	2	7	50	104	108	10	138	55	34	300	72	140	68	120	++++	..	++	..	++
E. (16)																			
Boy, 13 yrs.	2	7	30	106	118	10	130	35	24	120	80	132	52	120	..	++			
Wt., 78 lb.	2	7	40	110	120	5	140	50	30	180	96	136	40	120	+++	+++	..	..	+
Ht., 56 in.	2	7	50	110	126	10	146	50	36	240	75	148	73	120	+++++	..	++	..	+++
H. (17)																			
Boy, 9 yrs.	2	5	20	118	118	5	142	30	24	120	88	136	48	120	..	++			
Wt., 68 lb.	2	5	30	110	110	10	138	50	28	180	100	160	60	120	+++	+++	..	..	+
Ht., 52 in.	2	5	40	110	110	10	144	60	34	240	92	160	68	120	+++++	..	++	..	++
C. (18)																			
Boy, 10 yrs.	2	5	10	136	132	10	150	35	14	120	108	140	32	120	+	++			
Wt., 84 lb.	2	5	30	120	130	10	148	45	28	180	84	132	48	120	++	+++			
Ht., 57 in.	2	5	40	122	132	10	154	50	32	240	84	160	76	120	++++	..	..	..	++
T. (19)																			
Boy, 10 yrs.	2	5	30	110	100	5	140	35	30	120	76	120	44	120	..	++			
Wt., 65 lb.	2	5	40	114	110	10	144	50	30	180	72	124	42	120	++	+++	..	..	+
Ht., 54 in.	2	5	50	110	114	10	148	60	38	240	80	114	36	120	+++++	+++	..	..	+++
J. (20)																			
Girl, 13 yrs.	2	5	20	110	106	10	138	35	28	120	84	124	40	120	..	++			
Wt., 89 lb.	2	5	30	110	108	10	146	45	36	180	84	144	60	120	++	++			
Ht., 63 in.	2	5	40	110	118	10	160	50	42	240	84	152	68	120	++++	+++	..	..	++

Tabulated average of one complete experiment on each of twenty subjects, showing reactions of pulse and blood pressure following a series of increasing amounts of exercise at a constant rate of two seconds to each swing.

is similar to that obtained by Barringer, and by Cotton, Rapport and Lewis, and is considered by Barringer to be of peculiar significance; viz., that the delayed rise of systolic pressure after work indicates that the reserve force of the heart has been overtaxed.

This type of curve showing a delayed rise and a prolonged fall was present in 88 per cent. of the experiments, and in 85 per cent. it was accompanied by clinical symptoms of marked dyspnea and fatigue.

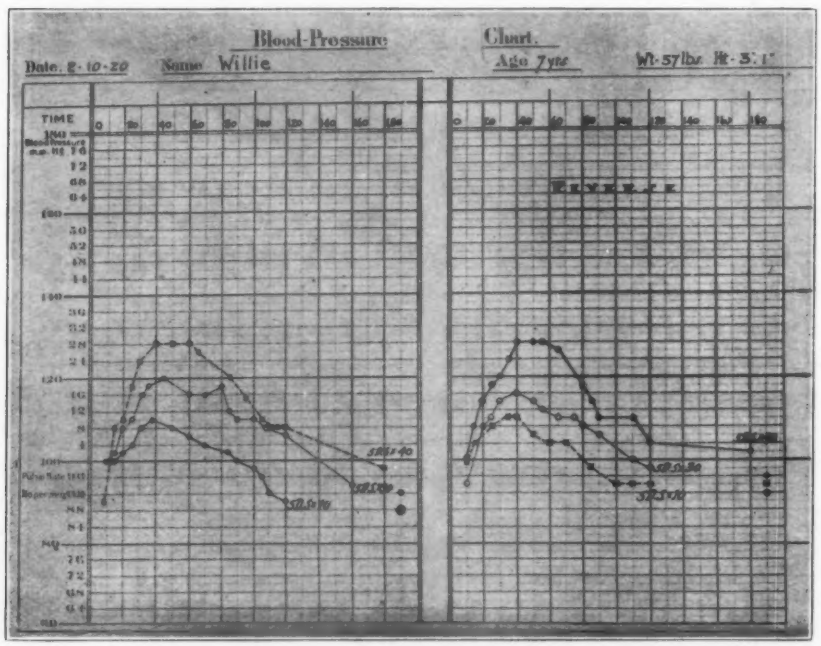

Fig. 6.—Chart showing comparative study of similar typical curves of systolic blood pressure reactions following identical test exercises on the same day, *but given in reverse order,* with one hour rest between each series.

The rise of blood pressure varied from 2 to 55 mm. The maximum blood pressure reading was 160. The rise varied directly with the increased quantity of exercise, and in 92 per cent. of the experiments the rise was proportional to the increased amount of dyspnea and fatigue.

It has been found that similar test exercises resulted in similar curves, with little variation from day to day, and a change in the order of the exercises produced no change in blood pressure curves (Fig. 6). The severest test exercise was followed by the same pressure curve (delayed rise, etc.), regardless of the order in which it was given (Fig. 7).

The effect of training was observed in that children were able,

toward the close of the period of observation, to perform increasing amounts of exercise without producing this delayed rise, dyspnea and fatigue.

It was interesting to note that children who subsequently became ill, showed just before their illness and later in their convalescence, a delayed rise, dyspnea and fatigue after moderate exercise which previously had been performed without such reactions.

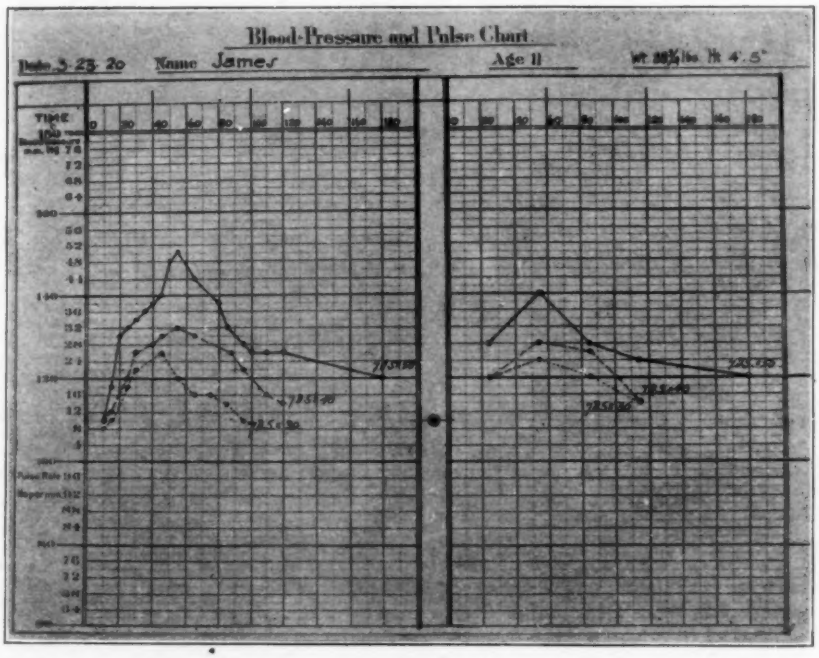

Fig. 7.—Chart showing comparative study of frequent and infrequent methods of plotting systolic blood pressure curves immediately after exercise. Curves to the left indicate frequent method of readings; those to the right, infrequent.

CONCLUSIONS

From these experiments on the circulatory reactions after exercise in twenty normal children, it may be concluded that:

1. The circulatory reactions to graduated exercise obtained in normal children are similar to those reported in adults.

2. The circulatory reactions immediately following similar graduated exercise at two day intervals over a period of weeks are, as a rule, constant.

3. The time required for the pulse rate to return to normal does not give much information as to the "exercise tolerance" of a child.

4. A type of systolic blood pressure curve after exercise, showing an increased rise, delayed rise and summit and a prolonged fall, and associated with symptoms of marked dyspnea and fatigue, would seem to indicate that the "exercise tolerance" of that particular child has been temporarily reached or exceeded.

Thanks are hereby extended to Dr. Oscar M. Schloss for his interest, and to Dr. Theodore B. Barringer, Jr., for his many helpful suggestions in this work.

I wish also to express my appreciation to Dr. Anna Kleegman-Daniels for her able assistance in conducting these experiments.

FURTHER PROGRESS IN THE STUDY OF THE RELATIVE EFFICIENCY OF THE DIFFERENT MERCURIAL PREPARATIONS

IN THE TREATMENT OF CONGENITAL SYPHILIS IN INFANTS AND CHILDREN, AS DETERMINED BY A QUANTITATIVE ANALYSIS OF THE MERCURY ELIMINATION IN THE URINE *

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ST. PAUL

The treatment of syphilis with the different mercurial preparations is still a haphazard affair, the rule being to give as much mercury as the patient will tolerate without salivation or diarrhea.

Assuming that the amount of mercury eliminated in the urine during a given time would give a fair index of the amount in the circulation, Ramsey and Ziegler made some experiments, the report of which was read before this society in 1918.[1]

From this series of experiments we were able to draw the following conclusions:

In infants and children, mercury, when given by the month, by inunction or intramuscularly, is excreted at least partly by the urine.

In new-born infants and older children mercurial ointment when placed in contact with the skin, without any friction being used (protected and sealed by wax paper from being volatilized and inhaled), is taken up by the skin and excreted in the urine and continues to be excreted in the urine for a variable time after all treatment has been discontinued.

By inunction (with rubbing) mercury is readily taken up by the skin and eliminated in the urine and continues to be eliminated for a considerable time.

When one inunction is given, the maximum daily amount of mercury is usually eliminated during the following twenty-four hours, smaller amounts being eliminated for a variable time.

Where continuous inunctions are given, there is an accumulation in the system and considerable amounts are eliminated at intervals with only traces between.

Mercury salicylate suspended in oil and given subcutaneously continues to be eliminated in the urine in appreciable amounts for eight days, or longer, the daily amounts eliminated varying widely.

Mercuric chlorid by intramuscular method, a favorite method in congenital syphilis, continues to be eliminated for eight days or longer.

In all cases in which mercuric chlorid was used either by mouth or the intramuscular method, protein was found in the urine.

In this new series of experiments, we have sought to determine, with some degree of accuracy, the amount and rapidity of absorption

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* From the Department of Pediatrics, University of Minnesota.

* Read before the American Pediatric Society, May-June, 1920.

1. Am. J. Dis. Child. **16**:299 (Nov.) 1918.

of the common mercurial preparations in use as determined by quantitative estimate of the amounts eliminated in the urine.

The method is the same as that employed in the previous experiments.

It will be observed that when 50 per cent. ointment was used, the elimination began soon after administration, the maximum elimination occurring during the following three days, the elimination being fairly complete within five days.

TABLE 1.—UNGUENTUM HYDRARGYRI (50 PER CENT.) (1 GM. OF OINTMENT USED)

Name and Age	Amount and Method of Administration of Mercury	Date of Administration	Date of 24-Hour Specimen	Amount of Mercury in Mg.	Remarks
M. S., 3½ years	Unguentum hydrargyri (50%) 1 Gm. as inunction	9/24	9/25	0.50	Congenital syphilis; Wassermann positive; female
			9/26	0.60	
			9/27	0.40	
			9/28	—	
			9/30	—	
	Unguentum hydrargyri (50%) 1 Gm. as inunction	10/1	10/1*	—	
			10/2	0.55	
			10/3	0.45	
			10/4	0.10	
			10/5	+	
			10/6	—	
			10/7	—	
	Unguentum hydrargyri (50%) 1 Gm. not by inunction	10/8	10/8*	—	
			10/9	0.40	
			10/10	0.20	
			10/11	0.12	
			10/12	+	
			10/13	—	
			10/14	—	
			10/15	—	
L. F., 5 years	Unguentum hydrargyri (50%) 1 Gm. as inunction	4/5	4/5*	—	Normal child; female
			4/6	+	
			4/7	0.42	
			4/8	0.12	
			4/9	+	
			4/10	±	
			4/11	—	
			4/12	—	
			4/13	—	
	Unguentum hydrargyri (50%) 1 Gm. not by inunction	4/14	4/14*	—	
			4/15	+	
			4/16	0.28	
			4/17	+	
			4/18	+	
			4/19	—	
			4/20	—	

* 24-hour specimen taken on day of administration of mercury.

When double the amount, 2 gm. of the 50 per cent. ointment, was used as inunction, the amounts eliminated were relatively larger.

With the 33⅓ per cent. mercurial ointment, even when double the quantity was used, the elimination did not begin in appreciable amounts until the second day after inunction, and then in much less quantities than when the 50 per cent. ointment was given.

When the mercurial ointment was simply used by smearing on the skin, without rubbing, the amount eliminated was much less than when used as an inunction.

TABLE 2.—UNGUENTUM HYDRARGYRI (50 PER CENT.) (2 GM. OF OINTMENT USED)

Name and Age	Amount and Method of Administration of Mercury	Date of Administration	Date of 24-Hour Specimen	Amount of Mercury in Mg.	Remarks
D. H., 3 years	Unguentum hydrargyri (50%) 2 Gm. as inunction	7/31	7/31*	—	Congenital syphilis; Wassermann positive; female
			8/ 1	+	
			8/ 2	0.74	
			8/ 3	0.60	
			8/ 4	0.24	
			8/ 5	+	
			8/ 6	—	
	Same	8/ 7	8/ 7*	—	
			8/ 8	+	
			8/ 9	0.84	
			8/10	0.55	
			8/11	0.36	
			8/12	+	
			8/13	+	
			8/14	—	
			8/15	—	
	Unguentum hydrargyri (50%) 2 Gm. not as inunction	8/16	8/16*	—	
			8/17	+	
			8/18	0.34	
			8/19	0.14	
			8/20	+	
			8/21	—	
			8/22	—	
			8/23	—	

* 24-hour specimen taken on day of administration of mercury.

TABLE 3.—UNGUENTUM HYDRARGYRI DILUTUM (33 PER CENT.)

Name and Age	Amount and Method of Administration of Mercury	Date of Administration	Date of 24-Hour Specimen	Amount of Mercury in Mg.	Remarks
M. S., 3½ years	Unguentum hydrargyri dilution (33%) 2 Gm. as inunction	10/15	10/15*	—	Congenital syphilis; Wassermann positive; female
			10/16	0.20	
			10/17	+	
			10/18	+	
			10/19	—	
			10/20	+	
			10/21	—	
	Unguentum hygrargyri dilution (33%) 2 Gm. as inunction	10/22	10/22*	—	
			10/23	+	
			10/24	+	
			10/25	—	
			10/26	+	
			10/27	—	
			10/28	—	
			10/29	—	
A. E., 7 years	Unguentum hydrargyri dilution (33%) 2 Gm. as inunction	4/ 5	4/ 5*	—	Normal child; male
			4/ 6	0.10	
			4/ 7	+	
			4/ 8	+	
			4/ 9	+	
			4/10	+	
			4/11	—	
			4/12	—	
	Unguentum hydrargyri dilution (33%) 2 Gm. not as inunction	4/13	4/13*	—	
			4/14	+	
			4/15	+	
			4/16	—	
			4/17	—	
			4/18	+	
			4/19	—	
			4/20	—	
			4/21	—	

* 24-hour specimen taken on day of administration of mercury.

In the case of calomel ointment, it will be seen that the elimination is delayed, and the total quantity eliminated is much less than with the mercurial ointment, although two grams was used for each inunction.

With the mercurial salicylate in oil, used hypodermically, it will be seen that the maximum elimination is in the first twenty-four hours—smaller quantities continuing to be eliminated for six or seven days.

TABLE 4.—CALOMEL UNGT. (30 PER CENT.)

Name and Age	Amount and Method of Administration of Mercury	Date of Administration	Date of 24-Hour Specimen	Amount of Mercury in Mg.	Remarks
L. F., 5 years	30% calomel unguentum 2 Gm. as inunction	4/20	4/20*	—	Normal child; female
			4/21	—	
			4/22	+	
			4/23	0.12	
			4/24	+	
			4/25	—	
	Same as above	4/26	4/26*	—	
			4/27	—	
			4/28	+	
			4/29	0.24	
			4/30	+	
			5/ 1	—	
			5/ 2	—	
			5/ 3	—	
J. B., 3 years	30% calomel unguentum 2 Gm. as inunction	8/15	8/15*	—	Congenital syphilis; Wassermann positive; female
			8/16	—	
			8/17	+	
			8/18	0.14	
			8/19	+	
			8/20	—	
			8/21	—	
			8/22	—	
	Same as above	8/23	8/23*	—	
			8/24	—	
			8/25	+	
			8/26	0.30	
			8/27	+	
			8/28	—	
			8/29	+	
			8/30	—	
	30% calomel unguentum 2 Gm. not as inunction	8/31	8/31*	—	
			9/ 1	+	
			9/ 2	+	
			9/ 3	—	
			9/ 4	+	
			9/ 5	—	
			9/ 6	—	
			9/ 7	—	
	30% calomel unguentum 2 Gm. not as inunction	9/ 8	9/ 8*	—	
			9/ 9	+	
			9/10	—	
			9/11	+	
			9/12	+	
			9/13	—	
			9/14	—	
			9/15	—	

* 24-hour specimen taken on day of administration of mercury.

The mercuric chlorid solutions used hypodermically continued to be eliminated in amounts not sufficient to be measured for six or seven days. In one case there was an appreciable amount of protein in the urine following its use, a point which we also observed in our previous experiments.

TABLE 5.—Mercury Salicylate in Oil (Intramuscular Injection)

Name and Age	Amount and Method of Administration of Mercury	Date of Administration	Date of 24-Hour Specimen	Amount of Mercury in Mg.	Remarks
J. F., 3½ years	Mercury salicylate (0.065 Gm.) in oil; intramuscular injection	4/ 5	4/ 5*	—	Normal child; male
			4/ 6	0.65	
			4/ 7	0.16	
			4/ 8	+	
			4/ 9	+	
			4/10	+	
			4/11	+	
			4/12	—	
			4/13	—	
	Same as above	4/14	4/14*	—	
			4/15	0.55	
			4/16	+	
			4/17	+	
			4/18	+	
			4/19	+	
			4/20	—	
			4/21	—	
M. L., 4½ years	Same as above	4/20	4/20*	—	Normal child; female
			4/21	0.46	
			4/22	+	
			4/23	+	
			4/24	+	
			4/25	+	
			4/26	—	
			4/27	+	
			4/28	—	
			4/29	—	
M. B., 6 years	Same as above	8/15	8/15*	—	Congenital syphilis; female
			8/16	0.60	
			8/17	0.18	
			8/18	+	
			8/19	+	
			8/20	+	
			8/21	+	
			8/22	+	
			8/23	—	
			8/24	—	

* 24-hour specimen taken on day of administration of mercury.

TABLE 6.—Mercuric Chlorid (Itramuscular Injection)

Name and Age	Amount and Method of Administration of Mercury	Date of Administration	Date of 24-Hour Specimen	Amount of Mercury in Mg.	Remarks
M. L., 4½ years	Mercuric bichlorid, 0.5 C.c. of 10% solution intramuscularly, i. e. 0.005 Gm. of mercury	4/ 5	4/ 5*	—	Normal child; female
			4/ 6	++	
			4/ 7	+	
			4/ 8	+	
			4/ 9	+	
			4/10	+	
			4/11	—	
			4/12	—	
			4/13	—	
	Same as above	4/14	4/14*	—	
			4/15	++	4/15, urine gave faint protein test
			4/16	+	
			4/17	+	
			4/18	+	
			4/19	—	
			4/20	—	
J. F., 3½ years	Mercuric bichlorid, 0.5 C.c. of 1% solution intramuscularly, i. e. 0.005 Gm. of mercury	4/20	4/20*	—	Normal child; male
			4/21	++	
			4/22	+	
			4/23	+	
			4/24	+	
			4/25	+	
			4/26	+	
			4/27	—	
			4/28	—	

* 24-hour specimen taken on day of administration of mercury.

TABLE 7.—CALOMEL (BY MOUTH)

Name and Age	Amount and Method of Administration of Mercury	Date of Administration	Date of 24-Hour Specimen	Amount of Mercury in Mg.	Remarks
M. F., 7 years	Calomel 1 grain by mouth	4/ 5	4/ 5*	—	Normal child; female
			4/ 6	+	
			4/ 7	+	
			4/ 8	+	
			4/ 9	+	
			4/10	+	
			4/11	—	
			4/12	—	
			4/13	—	
	Calomel 1 grain by mouth	4/14	4/14*	—	
			4/15	+	
			4/16	+	
			4/17	+	
			4/18	+	
			4/19	+	
			4/20	—	
M. B.,	Calomel ¼ grain by mouth every 4 hours for 4 doses	8/24	8/24*	—	Congenital syphilis; female
			8/25	+	
			8/26	+	
			8/27	+	
			8/28	+	
			8/29	+	
			8/36	+	

* 24-hour specimen taken on day of administration of mercury.

TABLE 8.—GRAY POWDER (BY MOUTH)

Name and Age	Amount and Method of Administration of Mercury	Date of Administration	Date of 24-Hour Specimen	Amount of Mercury in Mg.	Remarks
M. F., 7 years	Gray powder 3 grains by mouth every 4 hrs. for 4 doses	4/20	4/20*	—	Normal child; female
			4/21	±	
			4/22	+	
			4/23	+	
			4/24	—	
	Same as above	4/25	4/25*	—	
			4/26	+	
			4/27	—	4/26
			4/28	+	Frequent stools; some tenesmus
			4/29	+	
			4/30	—	
			5/ 1	—	
M. S., 3½ years	Gray powder 3 grains by mouth	11/24	11/24*	—	Congenital syphilis; female
			11/25	±	
			11/26	—	
			11/27	—	
			11/28	—	
	Gray powder 3 grains once daily for 5 days	11/29	11/29*	—	
		11/30	11/30*	—	
		12/ 1	12/ 1*	+	
		12/ 2	12/ 2*	±	
		12/ 3	12/ 3*	±	
			12/ 4	+	
			12/ 5	—	
	Gray powder 3 grains every 4 hours for 4 doses	12/ 6	12/ 6*	—	
			12/ 7	—	
			12/ 8	0.14	
			12/ 9	+	
			12/10	—	
			12/11	—	
			12/12	—	
			12/13	—	
			12/14	—	

* 24-hour specimen taken on day of administration of mercury.

Calomel given by mouth (1 grain) either in one dose or divided doses, was eliminated in appreciable amounts although not sufficient to be measured for six or seven days.

Gray powder, although given in large doses, was eliminated to a very small extent and for a short period of time.

The practical deductions which may be drawn from this series of experiments are, therefore, as follows:

1. Mercurial ointment, 50 per cent., is to be preferred to the less concentrated forms and need not be repeated more often than twice weekly instead of daily. The quantity of mercury absorbed is much increased by friction.

2. Calomel ointment is absorbed but less rapidly and to a less extent than the mercurial ointment and should, therefore, be given in greater concentration.

3. The salicylate of mercury in oil should be given hypodermically twice weekly instead of once.

4. The mercuric chlorid, by hypodermic injections, although the dose is very small, continues to be eliminated for six or seven days. The fact, however, that its use frequently is followed by the appearance of protein in the urine should exclude it from the treatment of syphilis in children.

5. Calomel by the mouth is absorbed in small amounts, and continues to be eliminated for a considerable time so that it is probable that it would be sufficient to give it at intervals of several days, thus avoiding diarrhea.

6. Gray powder is absorbed to a small degree and eliminated rather rapidly so that large doses repeated daily would probably be necessary to maintain mercury in the circulation.

We shall continue our experiments and determine, if possible, whether the clinical results will bear out the observations made in these experiments. In one case (M. S.) of congenital syphilis, with marked keratitis, treated by inunctions of 50 per cent. mercurial ointment, once weekly, the clinical progress was apparently quite as satisfactory as in cases where daily inunctions were given.

STUDIES IN SPASMOPHILIA

I SPASMOPHILIA AND VITAMINS

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MINNEAPOLIS

Although spasmophilia has been studied from almost every angle, and vitamins, at the present time very much in prominence, are known to have definite influence on the functions of the nervous system, no previous attempt, so far as I am aware, has been made to associate the one with the other.

By the term spasmophilia or spasmophilic diathesis, as used in this series of studies, is meant, as Langstein and Meyer recommend in their text book,[1] the latent condition in which there is hyperexcitability of the nervous system as shown by the electrical reactions or Chvostek's sign or both. For the active condition, manifesting convulsions, laryngospasm, carpopedal spasm or pylorospasm, the term tetany is reserved. Electrical reactions which are considered definitely characteristic of the spasmophilic diathesis are those in which the anodal opening contraction (AOC) is less than the anodal closing contraction (ACC) and is less than 5 ma. or the cathodal opening contraction (COC) is less than 5 ma. in infants of 1 year and under. No particular attention was paid to the Chvostek phenomenon as a pathognomonic sign. Unfortunately, there were no cases of tetany available, though one case (I.K.) which gave a cathodal opening contraction (COC) of less than 5 ma. had had convulsions and laryngospasm one month before this work was begun.[2]

As the electrical reactions permit of quantitative determination, any slight increase or decrease in the electrical irritabilty of the little patients could easily be checked up, following administration of the

1. Langstein and Meyer: Säuglingsernährung u. Säuglingsstoffwechsel, Wiesbaden, 1914, p. 347.

2. The electrical reactions were tested with a Wappler wall plate apparatus, the indifferent electrode, being moistened with physiologic sodium chlorid solution, was placed on the abdomen, the Stintzig electrode, kept constantly moist with the solution, was applied to the peroneal nerve at the head of the fibula. The leg was held just above the malleoli, and the slightest twitch that could be felt, even though no movement of the foot or toes were visible, was taken as the minimum response or "end-point." An assistant held the indifferent electrode and moved the rheostat. The reactions were always done at the same time, in the morning. Very seldom did excessive crying or restlessness necessitate abandoning the tests.

material under investigation. The infants were studied during the winter months (December, January and February) when spasmophilia is most apt to become manifest. They were under constant observation in an institution; the diets were prepared in a central diet kitchen and under absolute control. Three of the children studied were in well ventilated cubicles, and had been in those cubicles for some months prior to the investigation. The remaining children were in an open ward. No changes were made in the dietaries during the period if study.

WATER SOLUBLE B

The water-soluble vitamin was administered to infants showing spasmophilic reactions in three ways: (1) by oral administration of filtered autolyzed yeast; (2) by subcutaneous injection of the yeast filtrate boiled for one minute; (3) by subcutaneous injection of a watery solution of the alcoholic extract of ether-extracted wheat embryo. This solution was prepared by me after the method described by McCollum and Simmonds,[3] modified slightly to meet the necessity of having a sterile product. Chloroform, 0.2 per cent., was added as preservative, and the well stoppered bottles were kept in the refrigerator. Cultures of the finished product planted on blood-serum agar slants showed no growth after seventy-two hours incubation.

The yeast filtrate was prepared by mixing equal quantities of dry commercial yeast powder and water, incubating for twenty-four hours, and filtering. The antineuritic activity of the yeast filtrate and of the wheat embryo extract was tested on pigeons made polyneuritic by a polished rice diet. Five c.c. daily, of either, by mouth, was sufficient to effect a recovery from the polyneuritic state in from two to three days.

Yeast Filtrate.—Table 1 is typical of the results of oral administration of the yeast to four children. In no case was there an improvement in the electrical reactions.

Table 2 shows that yeast filtrate given subcutaneously had no influence on the electrical irritability. Although A. G. shows an apparent decreased irritability twenty-four hours after the injection, on the following day the reactions had returned to their former status. T. S. shows no change other than is encountered in the daily variations of the reactions.

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3. McCollum, E. V., and Simmonds, N.: A study of the Dietary Essential Water-Soluble B, in Relation to Its Solubility and Stability Toward Reagents, J. Biol. Chem. **33**:55, 1918.

Wheat Solution.—Five infants were studied in this group, two of which (I. K. & T. S.) had previously received yeast filtrate. All were given two injections of 2 c.c. of the solution subcutaneously, then 4 c.c. were so given. In none were there any untoward effects; not even the slightest rise in temperature. Table 3 shows the results in one case, typical of the others. Another case in this group had been receiving yeast filtrate, 1 dram three times daily by mouth for five months previous to the wheat injections and showed the following spasmophilic reactions: CCC 0.6, ACC 2.0, AOC 1.6, COC> 5, which did not change after the administration of the wheat solution.

TABLE 1.—ORAL ADMINISTRATION OF YEAST

Name	Date	Therapy	Electrical Reactions			
			CCC	ACC	AOC	COC
I. K.	12/15/19	None	0.1	1.1	1.0	2.2
	12/16/19	None	0.1	1.6	1.1	2.2
2 mos.	12/17/19	1 dram t.i.d.	...	...	...	...
	12/18/19	1 dram t.i.d.	0.1	1.4	1.0	2.0
	12/20/19	1 dram t.i.d.	0.1	1.1	0.8	0.8
	12/21/19	2 drams t.i.d.	...	...	...	...
	12/27/19	2 drams t.i.d.	0.1	1.8	1.1	1.6
	1/ 6/20	2 drams t.i.d.	0.2	1.1	1.0	1.6

Diet: Elweiss milk, with 2.5 per cent. fat, 24 ounces; orange juice, ½ ounce daily.

TABLE 2.—SUBCUTANEOUS INJECTION OF YEAST FILTRATE

Name	Date	Therapy	Electrical Reactions			
			CCC	ACC	AOC	COC
A. G.	12/6/ 19	None	1.0	3.2	2.2	>5
	12/9/ 19	None	0.6	3.0	2.4	>5
10 mos.	12/10/19	2 c.c.	...	...	...	...
	12/11/19	None	1.2	3.0	3.0	>>5
	12/12/19	None	0.6	3.0	2.2	>>5
	12/15/19	None	1.1	3.0	2.2	>5
T. S.	12/ 4/19	None	1.2	3.0	2.5	>5
	12/ 9/19	None	1.6	4.8	2.1	>5
7 mos.	12/ 9/19	2 c.c.	...	...	...	...
	12/10/19	None	1.1	4.0	2.0	>>5
	12/12/19	None	1.6	2.8	2.8	>>5
	12/27/19	None	1.2	2.2	1.8	>5

Diet: A. G., whole milk modification; orange juice, 1 ounce daily. T. S., Elweiss milk with 2.5 per cent. fat; cereal; orange juice, ½ ounce daily.

Since none of these infants exhibited any permanent change in abnormal electrical irritability following administration of the water-soluble vitamin, it is safe to conclude that this abnormality was not due to a deficiency of this vitamin in their diet.

FAT SOLUBLE A

Electrical reactions were tested on four infants who had been on a dietary composed of 90 gm. of Krystalak (a highly skimmed, dried milk of less than 0.2 per cent. fat content), 30 gm. cane sugar, 15 c.c.

orange juice, 30 c.c. autolyzed yeast filtrate, 30 c.c. cotten seed oil and amounts of cream of wheat suitable to their ages, for a period of eight months. They are the infants studied by Hess and Unger [4] from the point of view of rickets and the fat-soluble vitamin. It will be noted that their dietary is as free from this vitamin as is ever obtained under the most severe clinical conditions, though otherwise entirely adequate. The electrical reactions were:

	CCC	ACC	AOC	COC
S. M.	0.6	2.0	1.6	>5
C. M.	2.6	3.0	>5	>5
R. S.	1.8	2.2	>5	>5
E. L.	2.8	3.0	>5	>5

With one exception, the reactions are entirely normal. As none showed any signs or symptoms of spasmophilia, the conclusion is justified that a minimal fat-soluble dietary component is not concerned in the etiology of the spasmophilic diathesis.

TABLE 3.—Subcutaneous Injection of Wheat Solution

Name	Date	Therapy	Electrical Reactions			
			CCC	ACC	AOC	COC
I. K.	1/27/20	None	0.4	1.2	1.0	2.2
	2/ 3/20	None	0.2	0.8	0.6	1.0
4 mos.	2/ 8/20	2 c.c.	...	...	...	...
	2/ 8/20	None	0.2	1.2	1.0	1.8
	2/10/20	2 c.c.	...	...	...	...
	2/11/20	None	0.3	1.2	1.0	2.5
	2/12/20	4 c.c.	...	...	...	...
	2/13/20	None	0.6	1.4	1.1	2.0
	2/14/20	4 c.c.	...	...	...	...
	2/27/20	None	0.5	1.4	1.1	1.8

Diet: Eiweiss milk, with 2.5 per cent. fat, 28 ounces; yeast filtrate, 2 drams, three times daily; orange juice, ½ ounce daily.

ANTISCORBUTIC VITAMIN

Opportunity presented itself of testing the electrical irritability in two cases of active infantile scurvy. Both patients showed the classical picture of bleeding gums, pseudoparalysis of the legs, the cardiorespiratory syndrome, capillary resistance test of Hess and one had subcutaneous and subperiosteal hemorrhages about the knee joint. Their electrical reactions were as follows:

	CCC	ACC	AOC	COC
S. K.	1.6	>5	>5	>5
S. F.	2.0	>5	>5	>5

These reactions show an irritability unusually low for children of their ages, both being 2 years old.

4. Hess, A. F., and Unger, L. J.: The Clinical Rôle of the Fat-Soluble Vitamin; Its Relation to Rickets, J. A. M. A. **74**:218 (Jan. 24) 1920.

DISCUSSION

In view of certain similarities between beriberi in its early stages and active tetany, it was thought that a deficiency in the diet of the antineuritic vitamin might play a rôle in the causation of spasmophilia. In both conditions the nervous system is involved, giving rise to such symptoms as hoarseness and laryngospasm. The end results of the two conditions, on the other hand, is entirely different, beriberi being rapidly fatal if not treated, spasmophilia rarely (per se) terminating in death.

The study here presented serves only to rule out the possible relation between the heightened electrical irritability—so-called "spasmophilic reactions"—and any deficiency in the diet of the water-soluble vitamin. This is all the more striking in view of the antineuritic content of orange juice, as shown by Osborne and Mendel[5] and more recently by Byfield and Daniels,[6] when we remember that the infants studied in this group were all receiving a liberal allowance of orange juice in their dietary, yet they showed the electrical changes characteristic of spasmophilia.

The very frequent association of spasmophilia and rickets, and the prominence which has recently been given to the fat-soluble factor in connection with rickets, serves only to add interest to the normal electrical reactions obtained in those children whose diet contained a minimal quantity of this factor.

No further comment is necessary on the reactions found in the scorbutic cases.

CONCLUSIONS

The evidence here presented shows that increased electrical irritability—so-called "spasmophilic reactions"—is not dependent on a deficiency in the diet of the water-soluble vitamin or of the other two known food accessory factors.

I wish to express my gratitude to Dr. Alfred Hess of New York for his many suggestions, advice and stimulating criticism.

5. Osborne, T. B., and Mendel, L. B.: Do Fruits Contain Water-Soluble Vitamin? Proc. Soc. Exper. Biol. & Med. **17**:46 (Nov. 19) 1919.

6. Byfield, A. H., and Daniels, A. L.: The Antineuritic and Growth Stimulating Properties of Orange Juice, Am. J. Dis. Child. **19**:349 (May) 1920.

CLINICAL DEPARTMENT

A CASE OF PRIAPISM RESULTING FROM RAPIDLY SPREADING MYXOSARCOMA WITH GENERALIZED METASTASES*

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REPORT OF CASE

Raymond G. (Case 5140), schoolboy, aged 9 years, entered the pediatric service of the University Hospital March 4, 1920. His chief complaints were lameness and stiffness of the back and neck; stiffness and difficulty in moving the left upper extremity; priapism, which had been persistent for about three weeks; some difficulty in swallowing and in articulating his words because of stiffness of the face muscles and inability to open his mouth freely; disturbed vision; headache situated in the right supraorbital region; difficulty in starting micturition, but no pain.

Family History.—The father, who is a laborer, had an accident six years ago last June: "Some ribs were broken and also his collar bone in two places." December, 1919, he had three marked hemorrhages in twenty-four hours which were thought to have been pulmonary. None since. "He is just as well now as he was before he had the hemorrhages." Mother's father and sister are said to have died of pulmonary tuberculosis. Mother died of what was called typhoid pneumonia. The history seems to show that shortly after Raymond's birth, there was strong suspicion that she was tuberculous. About three months after she was thought to be cured, she developed this fever, "typhoid pneumonia," which continued six weeks, and then she died. Raymond was the first child, born two years after marriage.

Past History.—Patient had measles when 4 or 5 years of age. He had no other infectious diseases. He was a strong baby. As he developed he became "moody," subject to dreamy spells; he would go off by himself and think and seem to be in a dream. He started in school at the age of 6 and advanced to the fourth grade. He always complained a great deal of headaches, cried easily and was hard to cheer up. He began to complain of his neck and back being stiff and aching about a year before entering the hospital. He was better in the warm weather. His "worst time seemed to be between January and May" so that when the present trouble began it was thought to be a recurrence of the same thing. There is a history of frequent earaches.

Injuries: He had been definitely hurt on two occasions, once when he was pushed off the schoolhouse platform, falling three feet, face down; "cried all afternoon saying his back hurt," and once when he had the coasting accident which has been thought to have played a great part in the development of his present illness.

Present Illness.—About Dec. 28, 1919, while sliding down hill, Raymond had one hand on each runner of the front of his sled, one knee on the back of the sled; with the other foot he was starting the sled down hill when his playmate jumped on his back. He went home screaming with pain in his back and his back was lame for several days. He returned to school. It was

* From the Department of Pediatrics and Infectious Diseases, University of Michigan.

* Read before the American Pediatric Society, Highland Park, Ill., May 31, June 1 and 2, 1920.

thought that after the accident his appetite became poor; that he was easily annoyed; the children playing seemed to bother him; while he played at times, he was not as playful as before. (This detailed account of the accident is given because of its possible connection with the development of the primary growth. Some have taken the view that it would be impossible to hurt the genital organs by such an accident, on the other hand, it is possible that he may have fallen astride the sled and thus injured the scrotum or perineum. There is no history of pain in this region.)

About the middle of January, 1920, he began to complain of pain and aching in his back. He again became stiff and was unable to bend over or to either side or to twist himself. His whole spine was rigid. Severe headaches developed, keeping him awake at night. He also, at this time, complained of dull pain in his knees which has occasioned a limp in his walk, more marked on the right side. About three weeks before entrance to the hospital, priapism developed and has been continuous. There is difficulty in starting urination; this is accomplished twice daily without pain or other abnormality. Soon after the development of priâpism he noticed that he was unable to see objects placed on the left of him and that his right eye turned in. The speech and swallowing defect date from the last fall when his jaws began to get stiff. He talks through his teeth without moving his jaw and he swallows with a definite impediment, choosing liquid foods. Difficulty in moving the left upper extremity is of recent occurrence. At times it is almost impossible for him to raise the left arm above the head.

Physical Examination on Entrance.—Slender prominent frame, wasted musculature; practically no panniculus; no edema. There is no play of the facial muscles. The jaw is stiff. The teeth open only 1.5 cm.; if an attempt is made to open the mouth it induces pain. The teeth are carious; *fetor exore.* The patient's body is stiff. The spine cannot be bent and the back muscles are stiff, like a board. He turns his head slightly from side to side, but this is largely accomplished by moving the body with it. He cannot move his head up and down. When he arises to the sitting position the head, neck and body are almost perfectly rigid. If any attempt is made to bend his back in any direction he cries out with pain. He has difficulty in raising the left upper extremity above the head. The other extremities show no limitation of motion. When the thighs are rotated there is pain in the hips. An attempt to rotate the legs causes pain in the knees. Grip in both hands is fair. The patella, ankle and elbow reflexes are not obtained. Babinski is negative; Oppenheim and Brudzinski cannot be obtained. (The knee jerks have been tested on many occasions. At one time they were thought to be present.) Pupils are equal and react promptly to light, slowly in accommodation. There is paralysis of the left external rectus. The patient is unable to rotate the left eye outward. There is no nystagmus. The vision in the right eye is definitely impaired; persons are seen as mere shadows; unable to count fingers or coins. There is definite tenderness on pressure above the right eye. There are no tremors. The other joints are prominent but show no abnormalities. The skin is pale and dry. There is considerable lanugo hair on the face and a slight amount of pubic hair. The glands are practically negative. The inguinal glands are felt, small. When the patient walks he does so with great care, standing with his body perfectly stiff and favoring the right extremity. When he attempts to pick up an object from the floor he bends at the knees and keeps the back straight.

The head is symmetrical and presents no abnormal prominences. Aside from the facies it is negative.

Thorax: Juvenile type. Pressure over the ribs at several points shows tenderness, otherwise negative.

Lungs: Percussion negative. Auscultation shows nothing definite. Spinal dullness extends only to the first dorsal. No d'Espine.

Heart: Negative.

Abdomen: Liver edge at costal margin. Kidneys and spleen not felt. The muscles are held very tense. No hernias.

Genitalia: Priapism is marked, continuous and painful if manipulated (Fig. 1). The prepuce can be retracted. No smegma. Both testicles felt in the scrotum.

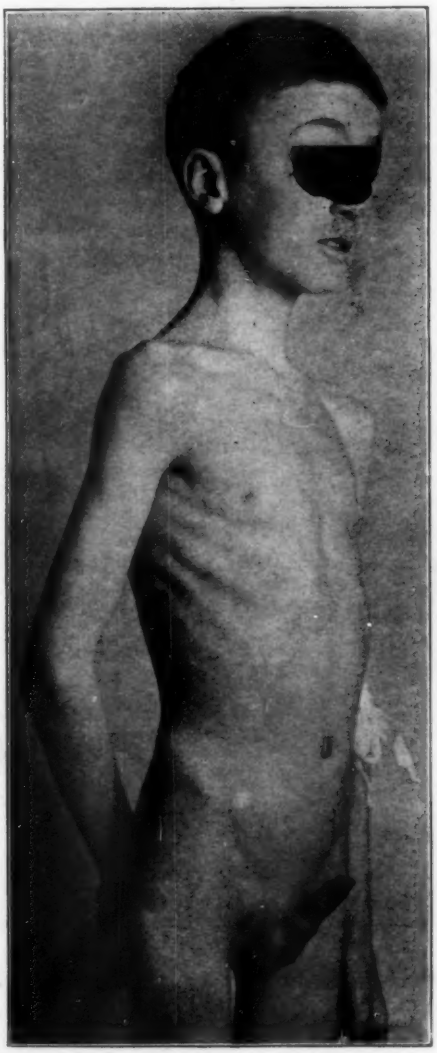

Fig. 1.—Taken soon after the tumor in the scrotum was first visible. The stiffness of back, neck and face muscles is evident; fixation of the jaw and priapism are marked.

Laboratory Findings.—Urine: The urine was examined on many occasions. Aside from high specific gravity it was negative. Urea and other biochemical tests not done.

Blood: March 4, 1920.—Red cells, 5,150,000; white cells, 12,000. Differential count shows polymorphonuclears, 71.2 per cent.; basophils, 4.1 per cent.; large lymphocytes, 17.1 per cent.; small lymphocytes, 7.6 per cent.

March 9, 1920.—Leukocytes, 18,000; hemoglobin, 62 per cent. Arneth count shows slight shifting to the left as follows: Mononuclear, 36 per cent.; binuclear, 35 per cent.; trinuclear, 23 per cent.; quadrinuclear, 5 per cent.; quinquinuclear, 1 per cent.

Fig. 2.—Showing the marked increase in size of the mass on the left jaw, the frontal nodule, and the nodule to the right of the sternum and the eye changes.

March 10.—Red cells, 4,400,000; white cells, 20,000.

Spinal Fluid: March 7.—Lumbar puncture in the sitting position; 4 c.c. of clear fluid came away under normal pressure. No more would flow out. Ten cells per field. Definite clouding with carbolic test. Otherwise negative.

March 9.—Lumbar puncture sitting position; 7 c.c. perfectly clear fluid under normal pressure was obtained. Cell count seven per field. Saturated ammonium sulphate negative. Phenol gives a definite cloud, positive. Fehling's test shows a reducing substance present. Collodial gold, 0112210000.

Wassermann: Blood and spinal fluid Wassermann negative.

Tuberculin Test: Repeated von Pirquet tests have been negative with 25 and 50 per cent. solutions.

Reports from Special Clinics.—Otolaryngology: Septic tonsils. Small mass of adenoids. Nasal cavities negative. No evidence of sinus disease. Ears negative.

Opthalmology: Optic neuritis, O. D., paralysis of left external rectus. Pupil, O. S., dilated more under mydriatic than O. D., indicating partial paralysis of the ciliary muscles O. S.

Syphilology: Clinical examination for hereditary syphilis entirely negative.

Roentgenology: Stereoroentgenogram of the head for sinuses shows all sinuses air containing, negative. The sella is normal in every respect. Roentgenogram of jaw is negative. Roentgenogram of spine, shows it to be perfectly normal.

Clinical Notes.—Temperature: Patient had an irregular temperature without any definite type, varying between normal and 101 F. (a few times it reached 102) until March 24, after which it remained practically normal until death, April 8, 1920.

The pulse rate varied between 100 and 140; otherwise nothing remarkable.

March 5.—A roentgen-ray examination suggests some involvement of the left upper chest (there was some suspicion of involvement of this part of the chest on the entrance examination). The spine is entirely negative.

March 8.—Priapism continues. There is a definite small mass in the scrotum posterior to the right testicle. The right testicle is free. The left is felt but is difficult to outline. There is a well circumscribed mass at the angle of the left jaw about the size of a hickory nut. It is fairly firm. The patient is unable to open his mouth more than 1 cm. He has difficulty in pronouncing words. There is nystagmus of the right eye when it is fixed on an object to the left. Knee jerks cannot be obtained.

Provisional Diagnosis.—Malignant tumor in the scrotum with metastasis in bone and cerebrum. The latter probably responsible for the eye signs. The tumor is probably a teratoma.

March 9.—Patient says he has to bear down very hard to start his urine, but there is no pain. The urine is clear.

March 11.—Patient is not as bright as a week ago. Return of his aunt caused no emotional reaction; he made no response to her salutation. He complains of persistent frontal headaches. There is pain on pressure over both supraorbital nerves during the past few days.

Metastases: Swelling half an inch in diameter has developed in the center of the forehead. This is firm and circumscribed. The swelling at the angle of the left jaw (Fig. 2) is increasing and is still firm. There is pain on pressure over the third right costosternal articulation and at the sternoclavicular joint. Patient complains of his back and calf muscles being sore. He seems to walk a little better.

March 10.—A large nodule is felt over the left occipital bone 3 cm. in diameter, firm, painful, elevated 0.5 cm. above the skull.

March 18.—The tumor mass in the scrotum is increasing in size. The jaw mass, which receded a bit after the roentgen ray was used, is larger. The teeth cannot be separated as well as before. It is difficult to understand what the patient says.

March 21.—Forehead nodule is 2 cm. in diameter. A smaller nodule has appeared on the top of the head, hard and attached to the bone, slightly tender to pressure. The occipital nodule is larger, very tender. The jaw nodule continues to enlarge; is more irregular. A similar nodule is developing on the right jaw in the same location. Scrotal mass is larger and is rapidly extending toward the anus. The right inguinal glands are now as large as small almonds. The patient was transferred to surgery service for biopsy.

Fig. 3.—Taken soon after death, showing the nodule recently developed on the right jaw and the extent of the scrotal growth.

March 23.—Tumor mass in the scrotum has grown very rapidly and is very hard. Both testes can be felt separate from the mass. A mass in the right inguinal region the size of a hickory nut is now felt (Figs. 3 and 4).

April 1.—A friction rub over the chest on both sides is heard, more noticeable on the right side than on the left. No change in the whispered or spoken voice. There is a small nodule on the third right costal cartilage near the sternum, the size of a large pea. The other nodules are all increasing in size and a new one is developing in the right temporal region which does not seem to be as hard as the others. The tumor mass in the scrotum is extending farther down, and is also beginning to extend up into the body of the penis. Mastication is now almost impossible. Patient is losing weight rapidly. The heart is negative. Patient complains of being short of breath.

Fig. 4.—A closer view to show the nodular masses along the penis and prepuce.

The chest is full of ronchi, particularly on the right side in the axillary region. No definite râles or dulness can be made out. The patient cannot be turned for examination of the back because of great distress. There is still pain on manipulation of the penis and the masses are more marked. Small nodules have developed up to the end of the prepuce.

In general, it may be said that the skull is full of nodules, altogether, large and small, seven are counted. The first one described over the left occipital bone is 4 cm. in diameter; the one over the forehead is 3 cm. in diameter. They project fully 1 cm. above the skull (Figs. 5 and 6).

April 2.—The process can be seen to advance daily. Nodules about the size of peas can be seen to have developed since yesterday. The left testicle seems to be lost in the tumor mass which is very much larger in all directions. Feeding by gavage.

April 7.—There are tubercles all along the penis up to the glans. A nodule has developed on the right superior maxillary, just external to the right orbit.

April 8.—Biopsy Report: Dr. Warthin reports the tissue as an alveolar myxosarcoma, congenital type, probably primary in the bladder.

The patient is slightly cyanotic this morning. The cyanosis extends down over the shoulders. The heart sounds are masked by the ronchi. The liver and spleen cannot be felt.

The patient died suddenly at noon.

SUMMARY

This is a case of a rapidly developing tumor in the scrotum associated with what I believe to be multiple metastatic growths in the skeletal structures, intracranial changes, indefinite intrathoracic changes particularly on the left side, not involving the heart; with a history of injury which, however, occurred, apparently, after he

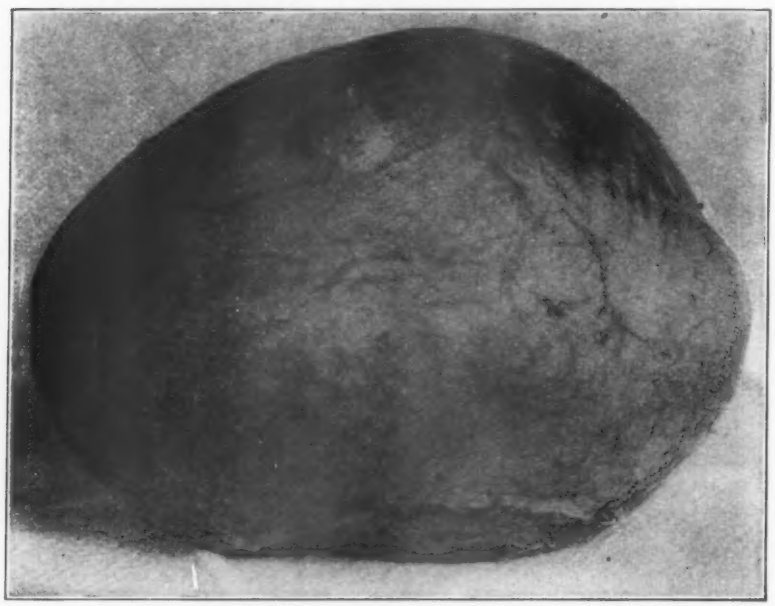

Fig. 5.—Skull cap outer surface.

first complained of back stiffness, but which may have had an influence in the process. We are thus far unable to determine the cause of the painful rigidity of the back and neck muscles. The patient seemed to be holding himself for fear of being hurt. The boardlike stiffness reminds one of that described by Escherich in his cases of pseudotetanus. This condition, however, is at once ruled out.

Instead of more than one process being at work to induce the different groups of symptoms, I believe the entire process is due to a malignant tumor with bone and visceral metastases. I have seen a number of malignant tumors in children in the clinic. Because of

bone metastases we made the tentative diagnosis of malignant teratoma. Dr. Cabot concurred in the idea of malignant tumor and Dr. Warthin, before the child's death, concurred in the probability of its being a teratoma.

NECROPSY PROTOCOL

The following notes are extracted from Dr. A. S. Warthin's necropsy records, made April 8, 1920.

Gross Findings.—There is a great abundance of lanugo hair over the face and upper extremities, nodular masses on the scalp and angles of both jaws, in the center of the forehead, on the costal cartilage at the junction of the

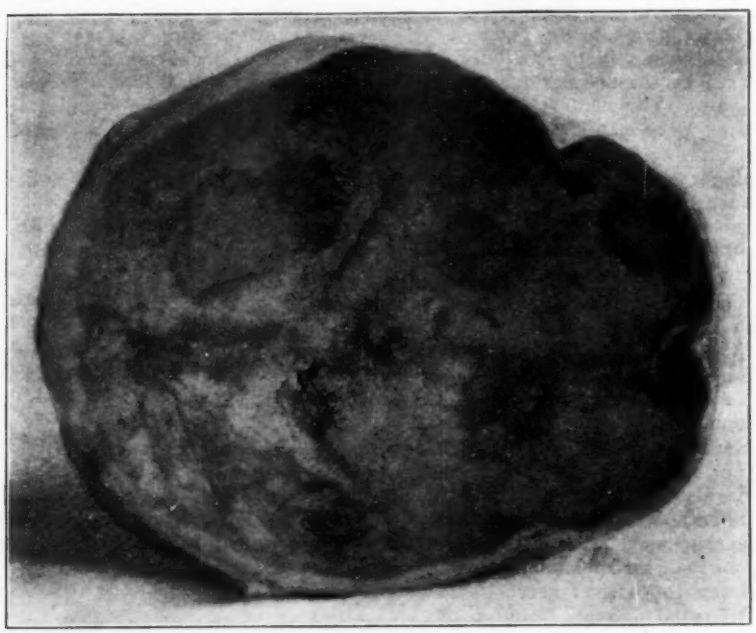

Fig. 6.—Skull cap inner surface.

third rib. Nodules were also found on the anterior surface of the sacrum. The bodies of the vertebrae were all involved, nodules being found on either side along the entire course of the spine. In the upper thoracic region there was a marked deformity bringing about anterior projection of the bodies of the thoracic vertebrae just behind the esophagus at the suprathoracic straits (this in part accounts for the difficulty in swallowing). The bodies of the vertebrae were infiltrated with the growth, so much so that they could be easily picked to pieces. The masses in the scalp were semi-elastic. The floor of the cranium was also involved in the tumor growth. There was a large soft metastasis involving the roof of the orbit and cavernous sinus on both sides, particularly the right.

Heart: The heart was negative, excepting for pallor of the heart muscles.

Lungs: The left lung was filled with metastases. The right was adherent. Both plueral cavities contained fluid. The fluid was slightly cloudy on the

right side. Some of the nodules on the surface of the left lung were from 1.5 to 2 cm. in diameter and elevated 0.5 cm. above the surface; light yellowish in color and resembling a button. One of these was umbilicated. The same buttonlike nodules were found on the upper surface of the diaphragm. The bronchial glands on the left were hyperplastic and edematous. No metastases. On the right they were entirely replaced by metastases the size of hickory nuts. When these were cut through they appeared soft, cheesy and yellow.

Stomach: Negative.

Pancreas: Negative.

Liver: Negative. One area showed a diffuse infiltration.

Spleen: Negative.

Intestines: Negative.

Genitals: The testicles were pushed up into the canal by the scrotal tumor and were not involved in the growth. The bones of the pelvis showed only secondary processes. The bladder showed no growth; the thickening in the wall was all in the subserosa. The primary growth was found in the prostate; the entire gland being replaced by the new growth. The urethra was surrounded by a soft, mushy, purulentlike growth. The penis was almost entirely replaced by the nodular masses varying in size from a buckshot to a pea.

Brain: The central longitudinal sinus contains metastatic nodules in its anterior portion. The circle is negative. The basal meninges are negative. The arachnoid shows irregular thickening between the convolutions. The meninges strip with difficulty, markedly edematous. There are adhesions between the arachnoid and the cortex. The ventricles are negative. The brain substance shows anemia but no metastases. The cerebellum, medulla and cerebral cord were edematous. The hypophysis was atrophic. The sella was nearly filled with neoplasm. The brain weighed 1,330 gm.

Microscopic Findings.—Brain: Congestion and edema. No metastases in brain substance.

Cranium: Metastases in scalp, cranium and floor of skull. Show a picture of round cell alveolar sarcoma.

Vertebrae: All metastases show the picture of an alveolar round cell sarcoma.

Heart: Simple atrophy. Fibroid atrophy. No neoplasm.

Clot from Heart: A laminated mixed clot containing nests of tumor cells.

Aorta: Slight fatty degeneration of the intima.

Lungs: Purulent bronchopneumonia with numerous streptococci colonies. Numerous metastases, some of round cell and others of an oat-seed spindle cell histoid sarcoma. The centers of the metastatic growths show marked tendency to caseous necrosis.

Bronchial Lymph Glands: Show metastases. Calcareous healed tubercle.

Prevertebral and Mesenteric Nodes: All filled with metastases. Some of the large mesenteric vessels contain masses of tumor cells. The prevertebral ganglia and the roots of the spinal nerves are surrounded by masses of tumor cells.

Thymus: Many large corpuscles of Hassal.

Thyroid: Abundant colloid. No metastases found.

Tonsil: Moderate hyperplastic tonsillitis.

Spleen: Simple atrophy. Congestion. Thrombosis of splenic vessels. Small metastases in some of the splenic follicles.

Suprarenals: Atrophy. Slight lipoidosis.

Kidneys: Slight cloudy swelling. Congestion.

Pancreas: No metastases.

Liver: Slight atrophy. Cellular infiltration of some of the periportal islands.

Stomach: Simple atrophic catarrh.

Colon: Slight mucous colitis.

Appendix: Negative.

Small Intestine: Slight catarrhal enteritis.

Urinary Bladder: Slight chronic cystitis. Diffuse infiltration of the wall with neoplasm.

Prostate: No prostatic tissue can be recognized. Completely replaced by alveolar round cell sarcoma.

Penis: Corpora cavernosa and corpus spongiosum infiltrated with round cell alveolar sarcoma; in many places by cells of an oval or oat-seed shape. Numerous areas of simple caseous necrosis.

Hemolymph Nodes: Numerous phagocytes containing hemosiderin in sinuses.

Final Pathological Diagnosis.—Alveolar oat-seed sarcoma, primarily a myxosarcoma, arising in region of prostate. Infiltration of cavernous spaces of penis with chronic priapism; erosion of pubic bone; infiltration of bladder wall; multiple metastases in skull, vertebrae, ribs, sternum, lungs, pleura, diaphragm, spleen and lymph nodes; infiltration of cranial and spinal nerves and sympathetic ganglia; free ball thrombi containing neoplasm cells in right heart; thrombosis of retroperitoneal and splenic vessels with tumor cell embolism; terminal acute bronchopneumonia; general marasmus; fibroid atrophy of thymus; hemosiderosis of lymph nodes; postmortem pseudomelanosis.

The stiffness and sensitiveness of the back are now explained by the necropsy findings along the course of the spinal column.

PROGRESS IN PEDIATRICS

A REVIEW OF THE LITERATURE OF 1919 ON THE GENITO-URINARY DISEASES OF CHILDREN

LEWIS WEBB HILL, M.D.

BOSTON

MALIGNANT TUMORS OF THE KIDNEY

Rossi [1] reviews the literature on this subject and reports three cases. There are only a few instances of operative cures on record, and recurrence is frequent, but an operation is the only means of possible relief, and the success in one of his cases justifies high hopes with radical intervention. In one of the cases on record, the tumor compressed the ureter from the other kidney, inducing hydronephrosis in this, and the urine from the sound kidney found its outlet through the sarcomatous kidney, the ureter from this being still permeable. Enlargement of the kidney is always the first symptom of the malignant disease in children. Hematuria is not always present, and pain is an unreliable element in the differential diagnosis. His first two cases were in children 2 years of age; one was inoperable, but the other child recovered and seems still in perfect health, eight years since the nephrectomy. The tumor was a round cell sarcoma, weighing 600 gm. The child had been apparently healthly until two months before the operation. He removed the tumor likewise in the third patient, a girl aged 8, and the child seems well, but the interval since has been too short for the ultimate outcome to be known. In deciding whether the tumor was in the kidney or spleen, he found instructive the appearance of a zone of resonance in front of the tumor when the intestine was inflated. This resonance is not encountered with a tumor in the spleen. A tumor in the intestine or mesentery generally runs a very rapid course, entailing cachexia early. Such tumors are also extremely movable, while a tumor in the pancreas is not movable. A conglomerate of tuberculous glands might prove misleading, but almost invariably tumefied glands or other symptoms elsewhere would give the clue. A congenital cystic kidney may also simulate a malignant tumor. In a case of this kind, a hard elastic tumor in the kidney region, movable with respiration but without fremitus or resonance in front, without eosinophilia, the blood pictures and urine normal, was

1. Riv. di clin. Pediat. **16**:12 (Dec.) 1918; abstr., J. A. M. A. **72**:834 (March 22) 1919.

shown by exploratory puncture to be a cystic tumor implanted on the large right kidney. The left kidney was missing. Uneventful recovery followed the excision of the tumor.

THE SUPRARENALS

It is gradually being realized that the suprarenals, as well as the kidneys, may be the seat of pathologic changes in infectious diseases, and that such changes are not at all uncommon. McCarrison [2] studied the effect of a scorbutic diet on the suprarenals of guinea-pigs which were fed on crushed oats and autoclaved milk. The naked eye changes consist in enlargement of the suprarenals with increase in their weight and in congestion. The weight of the suprarenals of guinea-pigs dying of scurvy is approximately double that of healthy guinea-pigs. The microscopic changes consist in a hemorrhagic infiltration and disintegration of the cellular elements of the cortex and medulla. These changes occur in animals who may show no clinical evidence of scurvy during life. They are to be regarded as prescorbutic in character. In spite of the fact that the weight of the organs is twice as great, the total quantity of epinephrin contained in the glands is less than half that in those of healthy guinea-pigs.

Byrne [3] performed a necropsy on a number of war prisoners who died of starvation. He says "While working as a prisoner of war behind the German lines in a prison hospital (lager) it fell to my lot to carry out several necropsies on British and Allied soldiers who died in the lager. Many batches of prisoners arrived from neighboring working parties where they had been systematically underfed, and had been worked until they were physically prostrated. From each batch some members died a very short time after admission. I was greatly impressed by the size of the suprarenals in these cases. In a series of eight deaths from underfeeding the suprarenals were definitely enlarged, almost half again as large as normal. Macroscopically, the enlargement seemed to involve mostly the cortex. Apparently the suprarenals had hypertrophied to counteract the low blood pressure produced by starvation."

Comby,[4] quoting an article of Friederichsen's,[5] says that hemorrhage into the suprarenals is not rare in children. It appears as a fairly definite disease. It is usually bilateral, acute and rapidly fatal. In new-born babies, traumatism, an umbilical infection, or the sudden changes in the character of the circulation, might be causes; in older babies, infection of some sort is probably the cause. Fever was present

2. Brit. M. J. **2**:200 (Aug. 16) 1919.
3. Brit. M. J. **2**:135 (Aug. 2) 1919.
4. Arch. de med. d. enf. **21**:651 (Dec.) 1918.
5. Ugesk. f. Læger **79**:446 (March) 1917.

in all cases. Experimentally, it has been found that injection of various organisms into guinea-pigs may produce suprarenal hemorrhage, also the author saw it in a case of scarlet fever. The most striking clinical appearance about the children is the inertia and asthenia.

Hill [6] reports a case of acute nephritis in which a very low blood pressure (60) was accompanied by marked asthenia. The blood pressure became lower, and the asthenia more marked. A few days before death the blood pressure was so low that it could not be recorded. No necropsy was made, but the author believes that the suprarenals were involved in the same inflammatory condition that the kidneys were, and that this was the cause of death.

Cowie and Beaven [7] draw attention to the fact that the French school assumes the presence of suprarenal involvement in many of the acute infections, and believe that this complication follows certain infections as regularly as nephritis follows scarlet fever. Since three very prominent symptoms in influenza and influenzal pneumonia are asthenia, prostration and a low blood pressure, they are of the opinion that there is suprarenal damage in many of the cases. At necropsy they found no hemorrhages or other inflammatory changes in the suprarenals, but merely a hypoplasia. They tried epinephrin injections to combat the low blood pressure and asthenia, but conclude that they are of little value.

ENURESIS

Enuresis is much like whooping cough; dozens of remedies have been used to control it, none of which are very efficacious. If there were any really good treatment of enuresis, everybody would be using it, instead of employing the many widely varying methods that are used.

Provinciali [8] reviews the various theories that have been advanced to explain enuresis, and states that in eight out of ten children of this category roentgen-ray examination revealed anomalies in the lumbosacral portion of the spine. In only two were these parts of normal aspect. The children with these anomalies did not show any other appreciable signs of degeneracy. As children usually outgrow the enuresis in time, he urges roentgen-ray examination of their spines to see if it might not be possible to detect the nature of the anatomic changes which put an end to the enuresis.

Cameron [9] believes that most of the ordinary causes alleged to be important in enuresis have little to do with it (adenoids, phimosis, etc.). It is mostly a neurosis. He believes that suggestion is very important;

6. Am. J. Dis. Child. **17**:270 (April) 1919.
7. Arch. Int. Med. **24**:78 (July) 1919.
8. Pediatria **27**:567 (Sept.) 1919; abstr., J. A. M. A. **73**:1317 (Oct. 25) 1919.
9. Practitioner **100**:112, 1918.

the parents make so much of the enuresis that the child just naturally wets. Usually when the child is sent to the hospital it stops to wet, because nobody pays any attention to it. Enuresis is explicable if we assume that the want of control is due at the beginning to autosuggestion, or to the unwise attitude adopted toward the fault by the nurses and parents, and later kept up by the sense of shame and the mental distress involved.

As regards treatment, the procedures that have been advised may be divided into five groups.

1. Operative: Adenoid operation and circumcision.

2. Manipulative: (a) Injections of saline solution under the skin in the perineal region. (b) Distention of the bladder by hydrostatic pressure. (c) Tilting the foot of the bed so that the urine is thrown to the fundus of the bladder and the sensitive trigone is prevented from irritation.

3. Education: (a) Curtailing fluid intake. (b) Working at intervals. (c) Rewards and punishments.

4. Medical: Atropin and thyroid extract.

5. Suggestion: (a) Simple suggestion. (b) Hypnotic suggestion.

Cameron believes that the first four groups of therapeutic measures help only as a suggestion of cure.

To be successful, the treatment of enuresis must be conducted through and by means of the grown up persons who have the control of the children. To stop the development of enuresis in early infancy, we must intervene to prevent the concentration of the child's mind on the difficulty. The emphasis should be laid on successes, not failures. The child must be helped and encouraged to self-confidence and not rendered different or selfconscious. The child must learn to see that the thing is not so desperately tragic. He should be told that these persons always get well and that the trouble only goes on because he is worried about it and keeps thinking of it. If the whole environment of the child is bad which aggravates his nervous instability, he must be removed and put under the influence of someone else. In inveterate cases, hypnotic suggestion is always successful. Also, it is the home and the general management of the child which must be changed.

The house is the culture medium, and the crop grown in this case has not been satisfactory.

Pisek [10] believes that the great majority of cases of enuresis are due to a lack of control of the sphincter centers or the higher cerebral centers. If voluntary control is obtained over the lower centers, the patient is cured. Atropin may help a little, probably by decreasing the desire to urinate. Enuresis is more common in active, energetic chil-

10. Med. Clin. N. America **3**:350 (Sept.) 1919.

dren, who by night time give evidence of neuromuscular fatigue. The cure of these cases depends on detailed management, which includes rest, diet, bladder control exercises, psychic impressions and, in certain intractable cases, mechanical irritation of the sphincter. Having removed possible physical causes, such as phimosis or adenoids, the physician must acquaint himself with the details of the child's life, so that fatigue and excessive nerve stimulation may be avoided. Meats, meat soups, tea, coffee, pastry and all highly seasoned foods should be avoided. A two day rest cure is often beneficial, requiring that the child have his breakfast in bed, and he is not allowed out of bed until lunch time. Such a plan followed for two days each week, at the beginning and the end of the week often helps a great deal. The child should have a dry supper with as little liquid as possible after 4 p. m., and there should be no strenuous play in the afternoon. He is put to bed one hour after his supper and is taken up to urinate when the parents retire. During the day the child is required to urinate and to stop at the word of command. This teaches the higher centers to control the act. These control exercises are done at least three times a day in the presence of an attendant. The patient is given a report card which is filled out every morning indicating whether the bed was wet or dry and the number of times the control exercises were done. Young children who have not learned to write may affix a gold star for a dry bed and a red star for a wet one. These reports, which are mailed to the physician, make a deep impression and are extremely valuable adjuncts in the cure. (This is the most sensible article on enuresis that has been written this year.—L. W. H.)

PYELITIS

Lozano and Ruiz[11] give full details of twenty-five cases, all but five in girls. The colon bacillus alone was found in 25 per cent., and associated with other germs in 33 per cent. The disease was primary in less than 15 per cent., measles in 25 per cent. and infectious sore throat in about 10 per cent. The absence of bacteria in the urine suggests possible tuberculosis, but they had one case with negative findings in which the pyelitis seemed of toxic and nontuberculous origin. There was no mortality in their twenty-five cases, except in three tuberculous children. They emphasize the necessity for surveillance of the kidneys during acute infectious disease, giving fluids in abundance. Small doses of hexamethylenamin may be useful. The genital organs should be kept scrupulously clean, and phimosis, etc., corrected.

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11. Arch. espan. de Pediat. **3**:385 (July) 1919; abstr., J. A. M. A. **73**:1732 (Nov. 29) 1919.

Grulee [12] emphasizes the fact that cases of pyelitis rarely show any symptoms which point definitely to the involvement of the kidneys or the bladder. (Many cases present increased frequency, enuresis and dysuria, particularly if the bladder is involved.—L. W. H.) There are three types clinically, as follows:

1. The stormy type. The child is taken suddenly with high fever, convulsions and prostration or coma. In the first twenty-four hours the urine may contain no pus, but careful examination shows the presence of many motile bacilli in the sediment, and pus will be found usually at the end of forty-eight hours. These cases may run a rapidly fatal course, death occurring within two or three days. This is not a common type.

2. In this type, the baby becomes suddenly sick with a high fever, but there is usually slight prostration considering the height of the temperature, which may be 105 or 106 F. The prognosis is better than in the first type.

3. The third type is most frequent. Without the temperature being so alarming as in the first two types, it is still continuous. The child may be brought to the doctor on account of the temperature, or, perhaps, on account of loss of appetite or general debility. The course varies greatly. After the acute stage has passed, there is usually a low, irregular fever (if untreated) which may run for weeks. There is a marked liability to recurrence; one never knows when he has the disease under control.

Langer and Soldin [13] discuss the etiology of pyelitis. In most of the recorded investigations of the etiology of pyelitis which assert that the colon bacillus is the sole etiologic agent, the technic of investigation has not been without criticism. When it is realized in how many different diseases pyelitis may occur as a secondary complication, we begin to think that, perhaps, the primary offending bacterium has not been found because the colon bacillus may have overgrown it.

The authors believe that pyelitis is usually a secondary condition. It is especially likely to be secondary to "grippe," diphtheria, chickenpox, pemphigus, tuberculosis, furunculosis and epidemic meningitis; indeed, almost any acute infection in infancy is able to pave the way for a secondary pyelitis. A catheter specimen of adult urine is likely to be sterile. This is not true of infants. In a microscopic examination of the sediment, many bacteria can be seen, mostly gram-negative cocci, which belong to the group of *Streptococcus lacticus*. In children the *S. lacticus* has a tendency to implant itself in places of

12. Med. Clin. N. America **3**:93 (July) 1919.
13. Ztschr. f. Kinderheilk. **5**:19 (July) 1919.

low resistance. It is doubtful if this organism is of much pathologic significance. The colon bacillus also may exist in normal urine, and normally there is an antagonism between the two organisms, the colon bacillus being kept down. In pyelitis the colon bacillus overgrows and probably gets into the kidneys through an injured intestinal mucosa.

NEPHRITIS

Congenital Fetal Nephritis.—Dutrey and Widakovich [14] report the case of a prematurely born child of a woman who had 1.50 gm. per thousand albumin in the urine. Delivery was spontaneous, but the placenta weighed 1,950 gm., while the child weighed only 1,700 gm. There was general edema of the cord and membranes, and of the entire fetus. Lesions were found in the kidneys of the child, indicating chronic nephritis, and this nephritis in the child evidently had cooperated in the production of the edema. There was nothing to suggest syphilis in either mother or child. They know of only two other cases on record of congenital fetal nephritis, theirs being the third case to be published in accessible literature. In Sitzenffrei's case, the nephritis in the fetus was evidently acute.

Nephritis without Albuminuria.—Davidsohn describes three cases in which a focal glomerulonephritis was accompanied by many casts in the urine, but with slight and transient albuminuria or none at all. Oliguria was constant but not marked.

Purpuric Nephritis in Children.—Nobécourt's [15] patient was a girl, aged 17, who for four months had been presenting symptoms of rheumatoid purpura, but there had been no epistaxis, hematemesis or melena, and the purpuric eruption had never progressed to ecchymoses. Blood was noted in the urine on two occasions, and from 0.3 to 0.5 gm. albumin per liter was found constantly in the urine. These findings testify to simple albuminous nephritis persisting after the subsidence of the purpura. This purpuric nephritis is rarely accompanied by edema, uremia or high blood pressure. Even with retention of chlorids, this is slight and transient. On the other hand, purpuric nephritis without hematuria may be more tenacious; the albuminuria may persist for from two to four or even six months. Osler published the report of a case in which the purpura progressed in severe waves, with violent abdominal crises and edema. The urine contained albumin and casts but no blood, and the child finally died in uremic convulsions. In Nobécourt's own experience, bacteriologic examination was always negative. He never found azotemia, and

14. Semana méd. **25**:661 (Dec. 5) 1919.
15. Bull. méd. Par. **33**:503 (Sept. 13) 1919; abstr., J. A. M. A. **73**:1557 (Nov. 15) 1919.

the nephritis only exceptionally passed into a chronic phase. The hematuric form may subside completely in four or five weeks after an acute course, but usually it runs a subacute course and gradually improves, or it may persist indefinitely. The disease proved rapidly fatal, or only after several months, in about 25 per cent. of the cases cited. The characteristic features resemble those of cases of so-called primary nephritis or nephritis of unknown origin. Treatment should be addressed both to the purpura and to the nephritis. Nobécourt has been successful in some cases with subcutaneous injections of peptone. Calcium chlorid should also be tried. If it does no good, at least it does no harm. To act on the renal hemorrhage, tannin, ergot and krameria have been tried, but without much benefit. The main reliance is placed on dietetic measures, milk for a short time, then milk and vegetables, with a small amount of mutton or ham. Salt need not be discarded unless there is retention, but not much should be allowed as it may increase the hematuria. The child should be kept in bed a long time. Getting up may bring a wave of purpura and increase the albuminuria. Marini's patient eliminated 5.55 gm. of albumin in ten hours reclining, and 15.6 gm. when she got up. Careful treatment may ward off complications, but it does not modify the course materially.

Syphilitic Nephritis.—Hutinel [16] discusses nephritis occurring with congenital syphilis. He warns against the use of mercury in nephritis with congenital syphilis, as he has seen hematuria follow mercurial inunction. Intravenous injection of arsphenamin is the best procedure. Rapid improvement and definite cure must not be expected, as usually the nephritis is so far advanced that considerable scar tissue has probably formed. The nephritis may be of an acute nature, but does not tend to assume any special type. The kidney may develop symptoms after very slight causes, which indicates a lack of resisting power. The albuminuria is out of all proportion to the functional disturbance, and there is little tendency to edema.

Hemorrhagic Nephritis.—Buerger [17] believes that infection of the throat and tonsils is very important in this type of case. It is important to differentiate it from other genito-urinary conditions which give rise to hematuria. Very little is known of the pathology, but the pathologic changes may be very slight, and are likely to involve the glomeruli. It is usually difficult to find casts during the acute stage. Buerger calls special attention to the fact that there may be associated hemorrhage from the bladder, which gives rise to part of the hematuria.

16. Paris méd. **9**:65 (Jan. 25) 1919.
17. Med. Rec. **94**:105 (Dec. 21) 1918.

Classification and Etiology.—Hill [18] in a general discussion of nephritis in childhood lays special stress on the superiority of a simple clinical classification over the old pathologic classification. It is often difficult or impossible to tell from the clinical condition of the patient what the microscopic appearance of the kidney in question is, and into what group of the pathologic classification the patient should be placed. Also in a large number of cases the kidney shows mixed types of injuries and cannot be put definitely into one group. The pathologist is studying the end results of morbid processes, while the clinician is more interested in the condition of the kidney at the time than in its appearance after death; also it is more vital to him to consider the kidney in its relation to the general condition of the patient than for him to be able to visualize its microscopic appearance. Moreover, a given kidney in the course of months or years may pass through several different classes of the pathologic grouping, according to how the damage is progressing.

Hill's classification is as follows: 1. Acute hemorrhagic nephritis. 2. Acute exudative nephritis. 3. Subacute nephritis. 4. Chronic nephritis (ordinary type). 5. Chronic nepritis with infantilism (very rare). He believes that infection is the most important etiologic factor, and that of all the infections, tonsillitis is the most important. Some other acute infections following which he has seen nephritis occur, are impetigo, scarlet fever, otitis media, pneumonia, purpura, alveolar abscess, cervical adenitis, and stomatitis.

The prognosis of acute nephritis in general he believes to be good, and also in chronic nephritis it is surprising to see how well many children do. The duration of acute nephritis in children is variable. The duration of forty-nine acute cases studied by him is shown. By duration is meant the time from the onset until the urine is albumin free, and shows no blood or casts in the sediment. Duration of acute nephritis: Two weeks, 1 case; three weeks, 4 cases; four weeks, 2 cases; five weeks, 3 cases; six weeks, 2 cases; seven weeks, 6 cases; eight weeks, 6 cases; nine weeks, 5 cases; twelve weeks or over, 12 cases.

Kidney Function.—Mosenthal [19] discusses the "Treatment of Retention of Waste Products in Nephritis." Some cases of chronic diffuse nephritis may have a persistent albuminuria for years without progressive encroachment on the kidney function. He cites the case of a woman, aged 40, who had had marked albuminuria for fourteen years, but had a phthalein excretion of 45 per cent. and a normal two hour test. Nocturnal polyuria is one of the first signs of an inefficient

18. Am. J. Dis. Child. **17**:140 (April) 1919.
19. Med. Clin. N. America **3**:353 (Sept.) 1919.

kidney. The reason of nocturnal polyuria in subacute or chronic nephritis is an inability of the kidney to eliminate sufficient solids during the daytime to make the night a period of comparative rest and inactivity. In order to determine the retention of waste products, studies of the blood are of value. Mosenthal gives the following figures for the normal nitrogenous nonprotein constituents per hundred c.c. of blood: Total nonprotein nitrogen, 30 mg.; urea nitrogen, 15 mg.; uric acid nitrogen, 2 mg.; creatinin nitrogen, 2 mg.

The first to increase in the blood is uric acid, next urea, and finally creatinin. The degree of increase of uric acid in the blood is probably the most delicate test of kidney function that there is, and it usually reveals an impairment of renal activity even before the two hour test does. The institution of a salt free diet is the best way to get rid of edema, and it almost always is effective. Hot packs and purging are useful adjuncts, but are not nearly so important as a salt free diet. It is well to avoid diuretics, and it is possible to make an oliguria worse by their use. There are two types of uremia. One is associated with marked retention of substance that should be eliminated by the kidney, the other occurs without any increase of urinary excretory products in the circulation, and while renal function is normal or nearly so. In uremia fluids should be forced, even if edema is present, and bleeding, followed by transfusion, may be of considerable value.

Functional Tests.—Scheel [20] discusses the significance of functional tests. Lack of urea retention is not always an assurance of good prognosis, as even with a low blood urea, uremia may develop. Scheel found the highest urea retention in cases of chronic glomerulonephritis and true contracted kidney. The retention of urea is independent of a tendency to edema. There is usually a high blood pressure with retention, but either may occur alone. The urea content of the blood is an excellent indication for the institution of a low protein diet.

MacLean and DeWesslow [21] regard as the most valuable tests for kidney function (1) the urea and nonprotein content of the blood; (2) the diastatic content of the urine; (3) the concentration of urea in the urine after the administration of urea by mouth, and (4) the chlorid content of the urine.

When the available renal tissue is just insufficient to maintain nitrogenous equilibrium with a normal blood urea concentration, the blood urea immediately increases in amount in proportion to the extent of the kidney lesion. When the damage to the kidney is insufficient to produce an increase in the blood urea, evidence of inadequate function can be obtained by other tests. In recent acute cases of nephritis

20. Norsk. Mag. f. Lægevidensk. **80**:363 (April) 1919; abstr., J. A. M. A. **72**:1800 (June 14) 1919.

21. Quart. J. Med. **12**:347 (July) 1919.

there is generally some retention of urea, if the condition is at all severe. In unfavorable cases the concentration tends to increase, and in such patients the prognosis is often bad, in spite of a favorable clinical condition. In every case in which there was more than 300 mg. urea (not urea nitrogen [L. W. H.]) per hundred c.c. of blood, death occurred. A persistent increase in blood urea is a bad sign. Although there is a tendency to retention of urea in nearly all cases of acute nephritis, this is by no means true of chronic cases.

The diastatic activity of the urine is important. The urine contains a ferment capable of hydrolyzing starch. The general opinion is that there is a marked decrease of diastase in the urine in nephritis, especially in the "chronic interstitial" type. The average amount of diastase in the urine of healthy individuals is remarkably constant, and the authors have found that it is usually considerably decreased in nephritis.

To determine the diastatic activity of the urine, three solutions are required. Their technic is as follows: (1) A 1 per cent. solution of soluble starch in distilled water; (2) a sodium chlorid solution of about 1 per cent. strength, and (3) a solution of iodin of about 0.5 per cent. strength. Ten tubes of equal size are used. Decreasing amounts of urine, from 0.6 to 0.06 c.c., are added. The total volume in each tube is then made up to 1 c.c. by the addition of the sodium chlorid solution, and finally 2 c.c. of the starch solution is added to each tube. The tubes are shaken and put into a water bath at 37 C. for thirty minutes. They are then removed and nearly filled with cold water to stop the ferment action. One drop of the iodin solution is added to each tube, and starting from number one note is taken of the first tube in which a blue tint is observed. This tube contains just that amount of urine which failed to convert all the starch into dextrin under the conditions of the test. The tube next to this, which may be clear or may show a reddish tint, is taken as the "limit," and from this tube the diastatic value of the urine is calculated. This so-called "d" value is empirically expressed in units, and represents the number of cubic centimeters of 0.1 per cent. starch solution which the particular urine is capable of digesting in one-half hour at 37 C. This value is obtained by dividing the number of cubic centimeters of starch solution used (2 c.c.) by the amount of urine required to digest this amount of starch. For instance, if the necessary quantity of urine was 0.1 c.c., then the diastatic value equals 20. In normals the "d" value varies from 6.6 to 30, the average being from 10 to 25. It varies to some extent at different times of the day, and on this account it is best, when possible, to test a sample from the twenty-four hour urine. Generally speaking, a constant value below 6.6 may be taken to indicate a defective kidney. As a rule, in the authors' experience, a patient with a very low diastatic value during the early acute period of the disease does not get on well.

If chlorid is specifically retained, this will lead to a retention of water in order to prevent excessive salt concentration in the body. It is one of the functions of the kidney to keep the concentration of the chlorids in the plasma in the vicinity of 0.6 per cent. In patients passing practically no salt in the blood, salt concentration is little, if any, higher than in a normal patient who may be passing 15 gm. of sodium chlorid in a day.

The authors say of the relation between anatomic and functional pathology: "It matters little whether a kidney is found to be large or small, white or red, rough or smooth, soft or hard. What is really of importance is to ascertain to what extent the kidney functions are interfered with during life, and it appears to us that little is to be gained by a more or less artificial grouping based chiefly upon the naked eye appearances of the organ after death."

As regards treatment, they advise a low protein diet in the early stages, but state that they are by no means certain that protein does harm during the subacute and convalescent stages. "We do not really know whether protein in ordinary amounts in the diet does harm in any case, but in the present state of our knowledge it seems important to enforce protein restriction in acute cases."

Williams and Humphreys [22] studied the blood sugar in fifty patients with nephritis. They found that it ranged from 0.06 to 0.25 per cent. In the early stages of acute nephritis the blood sugar is normal. In the last stages, when the patient is in uremia, the blood sugar is very high, often equal to that of severe cases of diabetes. Also, certain chronic cases characterized by high blood pressure show a high blood sugar. The blood sugar level is not appreciably influenced by carbohydrate restriction in the diet.

Failure in nitrogen metabolism precedes, often by months, the rise in blood sugar, so that the latter is of a rather serious prognostic significance.

Diet in Nephritis.—Lemierre [23] remarks that the discovery of the harmfulness of salt in certain forms of nephritis is one of the most important discoveries of recent years. Patients with extreme edema, such as used to be restricted to a milk diet over long periods, now are seen to improve and thrive under Widal and Javal's diet yielding 1,500 calories. It is made of 200 gm. bread made without salt; 200 gm. raw meat; 250 gm. potatoes; 50 gm. sugar and 30 centiliters each of wine and coffee. With dry uremia, in distinction to uremia with dropsy, Achard and Paisseau recommend a diet containing 50 gm. meat; 200 gm. potato; 100 gm. rice and 50 gm. butter, representing 1,030 calories. If there is no abnormal retention of salt, it is unnecessary to

22. Arch. Int. Med. **23**:537 (May) 1919.
23. Paris Méd. **9**:34 (July 12) 1919; abstr., J. A. M. A. **73**:725 (Aug. 30) 1919.

restrict the intake of salt. The intake of water should never be less than 1.5 liters as the kidney may not be able to eliminate urea unless it is well diluted; the polyuria, therefore, is necessary. In acute nephritis there is retention of all the elements of the urine, hence substances that produce these elements must not be taken, while water should be given freely to flush the kidneys.

Experimental Production of Nephritis.—Newburgh [24] studied the effect of high protein diets on the kidneys of rabbits. The tubular epithelium may suffer any degree of injury, including death, as a result of its efforts to remove certain abnormal substances from the blood. "May it not be true that the kidneys can secrete a certain amount of nitrogenous matter for an indefinite time without suffering harm, but that they will be injured if the quantity of some or all of the nitrogenous substances secreted be increased and kept at the higher level for some time?" In order to determine the truth of this supposition, Newburgh fed rabbits on diets abnormally high in protein, using eggwhite, casein and soy beans. Renal injury was quickly and constantly produced in rabbits that ate several eggwhites daily. When the nitrogen metabolism was increased by means of casein, rabbits suffered no demonstrable renal injury from eating 15 gm. casein daily, but when the daily intake of casein was 30 gm., the nitrogen metabolism was about three times the normal, and a well marked deleterious effect on the kidney was noted. Rabbits that lived on soy beans for months regularly acquired chronic nephritis and frequently died of it. The nitrogen metabolism from this diet was about twice the normal.

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24. Arch. Int. Med. **24**:359 (Oct.) 1919.

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